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CONTENTS

	Page
International Co-operation	673
Advances in Carbohydrate Chemistry. By Prof. E. L. Hirst, F.R.S.	676
The First National Pharmacopœia. By Prof. J. H. Gaddum, F.R.S.	677
Control of Atomic Energy. By Prof. M. L. Oliphant, F.R.S.	679
An Estimate of the Age of the Earth. By Prof. Arthur Holmes, F.R.S.	680
Industry and Research	684
The Royal Academy, 1946. By Dr. A. T. Hopwood	686
New Foreign Members of the Royal Society	687
News and Views	688
Letters to the Editors :	
Two Anomalies in the Ionosphere.—Sir Edward Appleton, G.B.E., K.C.B., F.R.S.	691
Mesotron Intensity as a Function of Altitude.—Dr. P. S. Gill	691
The Auroral Spectrum.—Prof. S. K. Mitra	692
Electronic Spectra of some Bent Triatomic Molecules.—Dr. Jules Duchesne and Dr. B. Rosen	692
The Normal and Power Vortex in Meteorology.—R. W. James	693
Linear 'Curves of Best Fit'.—A. E. W. Austen and H. Pelzer	693
Flow of Gases through Fine Powders and the Measurement of Specific Surface.—W. R. Holmes ; P. J. Rigden	694
Optical Stability of Diphenyl Derivatives.—Dr. G. Baddeley	694
Cyclo-octatetraene.—Allan Maccoll	695
Secondary Electron Photography.—J. E. Roberts	695
Nickel and Multiple Trace Element Deficiencies in Agricultural Crops.—Dr. W. A. Roach and C. Barclay	696
Detection of Manganese Deficiency in Plants by Tissue Tests, Using Tetramethyldiaminodiphenylmethane.—D. J. D. Nicholas	696
Blood Groups in Tribes of Tierra del Fuego and their Bearing on Ethnic and Genetic Relationships.—Dr. Alexander Lipschutz, Dr. Girete Mostny, Dr. Louis Robin and Dr. Antonio Santiana	696
Determination of Dienœstrol in Biological Samples.—A. E. Wilder Smith	697
Folic Acid in the Nutrition of Certain Insects.—Dr. G. Fraenkel and M. Blewett	697
Gladiolic Acid : an Antifungal and Antibacterial Metabolic Product of *Penicillium gladioli* McCull and Thom.—Dr. P. W. Brian, P. J. Curtis, J. F. Grove, H. G. Hemming and J. C. McGowan	697
Cytological Localization of Riboflavin (Vitamin B_2) and Thiamin (Vitamin B_1) by Fluorescence Microspectrography.—Dr. Fritiof Sjöstrand	698
Pure Cultural Observations on Bacterial Infiltration of the Appendix in Rabbits.—John Enticknap and Frank Baker	698
Maximum Rate of Selection for Dominant Quantitative Genes.—Mrs. S. W. Boyce	699
Control of *Boophilus australis* in the Argentine by the Gamma Isomer of Hexachlorocyclohexane ('Gammexane').—Dr. C. N. Ault	699
Artificial Fertilization of Cod (*Gadus callarias* Linn.) at Port Erin.—K. Woodworth, H. G. Kewalramani, M. P. Motwani and Prof. J. H. Orton	700
Neotypes for Species Based on Pathological Specimens.—Dr. Otto Haas	700
Factorial Analysis of Colour Vision.—Dr. R. W. Pickford	700
Lantern Slides of Diagrams, Formulæ, etc.—The Rev. H. Santapau, S.J.	700
Research Items	701
Armstrong-Whitworth Tailless Glider	703
Transformer Oils	703
What is the True Shamrock? By Dr. Hugh O'Neill	704
New Crop Varieties	706
Exploring Magnetic Fields	706
Nephridia and Genital Ducts	707
Recent Scientific and Technical Books	Supp. ii

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INTERNATIONAL CO-OPERATION

THE speech which Sir John Boyd Orr delivered in the debate in the House of Commons on the world food shortage on April 4 is important in that it sets the problem in its true perspective and indicates the contribution to be expected from the Food and Agricultural Organisation. Sir John was concerned neither to attack nor defend the Government ; indeed, he is of opinion that any Government in power and any Food Minister would have been faced with the same difficulties and with much of the same criticism. The over-riding fact is the world food shortage and the inequitable distribution of available food ; and the temporary crisis, with which the United Nations Relief and Rehabilitation Administration and the Combined Food Board are dealing, and the long-term planning necessary to relieve the world for ever from hunger and malnutrition are clearly related.

Sir John said that the Food and Agricultural Organisation is already well advanced in its first task of bringing together all existing information on the pre-war position and the distortion of that position by the War, considering the measures which had been taken between the two World Wars to deal with food, their success or failure ; and, on the basis of that information, of working out a more permanent world food plan. He hoped that by the end of the summer the Organisation would be able to submit for the consideration of Governments and of the United Nations organisations concerned a plan which would go far to relieve the world of hunger and malnutrition and to bring about a rise in the standard of living of primary producers. It is important to formulate such a plan so that temporary measures at present being taken may dovetail smoothly into long-term measures. In the meantime, in view of the sudden deterioration in the food situation, the Food and Agricultural Organisation is holding a conference in Washington of bodies dealing with the food situation, with responsible Ministers from countries which may be able to contribute to the solution of the world food problem. Among the preparations for that conference is an assessment of the food position and of the prospects for 1946–47 and 1947–48. Sir John hopes for agreement on measures which can be taken to increase production, and he is also certain that measures can be taken to make better use and distribution of the available food. Agreement should also be reached as to measures which the Food and Agricultural Organisation could take to keep the whole position under continuous review so that Governments and peoples received adequate warning of any future crisis.

Sir John Orr did not minimize the difficulties which confront the Food and Agricultural Organisation or the conflicting interests that would have to be reconciled. He was able none the less to point to some encouraging signs, and his indication of ways in which the Organisation has been able to enlist the help of the best brains of the world was particularly welcome to a House which showed itself alive to the importance of exact scientific knowledge as a basis for action. Dr. Haden Guest, in particular, suggested

the possibility of using the methods of operational research, and urged the need for action based on an exact scientific appreciation, in the military sense of the word, of the problems of each country. Little could be gathered from the debate, however, as to how far the Government could count on support from all political parties in support of, for example, the difficult, unpleasant and unpopular measures which have since been taken to reduce British consumption of wheat—a further increase in the rate of extraction; reduced use of cereals for brewing and curtailed use of flour for cakes and biscuits. The consequences of these measures, namely, still darker bread and smaller supplies of feeding-stuffs for livestock, universal shortages of beer, and grave harm to a confectionery industry that has already suffered severely, must be serious. Yet the price is small if it will promote the world co-operation for which Sir John Orr pleaded. As he pointed out, the Food and Agricultural Organisation is a means whereby the nations may commence to operate something which will do none of them harm and all of them good, and thus merits every support. The food policy of Britain during the War was the admiration of all countries, and this is a further reason for showing the world that we intend to give all possible support to the Food and Agricultural Organisation. Sir John believes that in this crisis we can lay the foundation of permanent collaboration among the nations in a plan which would bring about a world food scheme based on human needs and would initiate a really benevolent revolution.

Sir John Orr's speech was of particular interest, for it came at a time when the meetings at Geneva to wind up the League of Nations and the hesitant start of the United Nations Organisation directed fresh thought to the causes of the failure of the League and aroused some misgivings regarding the new organisation. In the third Montague Burton Lecture on International Relations, "Victory and After", delivered at Leeds last June[1], Prof. Gilbert Murray based his hope of the future on two forces, both having power to penetrate unconsciously minds that may seem bitterly closed against them—the spread of truth and the awakening of the conscience of mankind. The main cause of all the crimes and miseries of the last ten years, he urged, was the dominance of the organised lie. If we could establish, for example, some system of world broadcasting of objective and well-attested facts, we could prevent whole nations being imprisoned in ignorance and fed on deliberate and organised myths. Secondly, by means of the Assembly of the Organisation, when facing problems of peace and war and all the greatest moral issues, we could give a voice to the conscience of the world.

Events during the past few months suggest that we have still far to travel along that road; but Sir John Orr is clearly in line with the thought of Prof. Gilbert Murray, and with ideas which have found forcible expression by scientific workers themselves, for example, in the Bush Report in the United States and Sir Edward Appleton's plea for freedom of publication at the recent Federation of British Industries Conference. If, in fact, either the Food and Agricultural Organisation or the Emergency Conference on European Cereals Supplies can secure the lifting of the 'iron curtain' which cuts off the grain-producing countries of Eastern Europe from the rest of the world and open the way to provision of information and supplies, real steps will have been taken not merely to lift the shadow of famine from Europe but also towards the functioning of genuine world co-operation. At least it should be clear to all that something more than tepid approval will be required if the United Nations Organisation is to prove a more effective instrument than the League of Nations. The latter failed, Lord Cecil urged, in his speech to the Assembly at Geneva on April 9, not because of any weaknesses in the terms of the Covenant, but solely because the member States did not accept the obligation to use and support its provisions.

In his final report on the work of the League during the War[2], the Acting Secretary-General takes a like view. Besides an admirable survey of the way in which the League maintained, throughout those terrible years, the machinery and technical services it had established in such fields as health, the drug traffic, economic, financial and transit questions, preventing serious gaps in international records which have become the backbone of the statistics of all nations, he goes on to speak of the larger lessons of the League's experience and their bearing on the success of the new Organisation. Any interruption in the series of scientific observations conducted by the League, particularly regarding epidemics and famines, might well mean fresh disasters. It is in the interests of all nations that these should continue without a break, and the United Nations Organisation has already recognized that these services of documentation, special inquiries and studies are essential to national and international reconstruction. Tribute has been paid to the work of the technical sections of the League, notably the economic, social health and opium sections, which together with the library and archives of the League are to be taken over by the United Nations Organisation; and the latter is equally indisposed to see the experienced personnel of the League simply disbanded and will take over many of those who have carried on these services so that continuity may not be lost.

Even more important, however, than the transfer of such material or even human assets to the United Nations Organisation is the continuity of the spiritual assets and tradition to which the Acting Secretary-General directs attention. Whether the new Organisation is in many respects better than the machine which is being discarded is not the most important thing. Success will depend on how it is used, on the justice, wisdom and courage of leaders, and, above all, on the vision and determination of the common people. The first great experiment in international co-operation for peace and human progress has been made, and its lessons must now contribute to the success of the second experiment. The problems remain the same, the objects are unchanged and methods cannot greatly differ. While the United Nations Organisation begins its work with the superlative advantage of the co-operation of all the world

Powers, the lessons of the past must be fully appreciated and the new instrument shaped and used in the light of all the experience gained with the old, the technical organs of which have so largely survived to provide a basis for the new Organisation.

The formal dissolution of the League of Nations should thus give a fresh stimulus to the essential task of educating public opinion as to what the United Nations Organisation really represents and how far it follows on the old League. A useful contribution to that end is an account of "The United Nations Charter"[3], including the text and a general commentary by Prof. David Mitrany, one on the Covenant and Charter by Prof. Gilbert Murray, on the Economic and Social Council by Prof. G. D. H. Cole, on the International Court of Justice by Prof. Norman Bentwich and on Colonies and the Trusteeship System by Dr. Rita Hinden. Prof. Mitrany emphasizes the new departures represented by the autonomous powers of decision and autonomous means of action given to the Security Council, but points out that political and technical factors aside, the main issue is the conception of security on which the whole scheme rests. Here we have made little progress beyond the League Covenant, but he urges that the readiness to pool economic resources and to join in their use is the road which leads both to international security and social security. Prof. Gilbert Murray urges that it is only through co-operation that nations learn to co-operate and thereby to understand and trust each other. Far more even than the League itself, the success or failure of the United Nations Organisation, he holds, depends on the public opinion, the interest, the conscience and active co-operation of intelligent persons throughout the more advanced nations, while Prof. Cole concludes that the economic and social articles hang on the success achieved in following common international policies by countries which agree to differ about such matters as public versus private enterprise, the range of economic and social planning, and the meaning of democracy in terms of institutions and the relation of the citizen to the State.

It is interesting to note that firm support for these views of Mr. Sean Lester and Prof. Gilbert Murray was given in a series of addresses to the American Academy of Arts and Sciences some four years ago on the ways in which learning derived from the systematic study of arts and sciences can profitably influence the re-organisation of civilization after the War. These addresses, concerned to close the gap between statesmanship and learning, have only now become available in the *Proceedings* of the Academy[4]. Mr. Z. Chafee, jun., for example, reviewing under the title "International Utopias" the experience of the League of Nations and such proposals as those of Clarence Streit for Federal Union, stresses the need in any new international organisation for a spirit determined to make it work, and also remarks on the importance of avoiding strains during its early years, emphasizing in this connexion the value of immediately freeing economic life as far as possible.

While there is much in this series of addresses which the man of science as well as others could ponder with profit—C. S. Coon's address on "Technology and Human Relations", C. M. Arensberg's on "The Nature of World Equilibrium" and E. D. Chapple's on "How a World Equilibrium Can be Organised and Administered" may be mentioned here—possibly the most fundamental is Prof. A. N. Whitehead's contribution on "Statesmanship and Specialized Learning". Prof. Whitehead stresses first the importance of the arts for the understanding of human life, and then, turning to the functions of a scientific association, points out that a simple-minded approach to practical politics is disastrous, although the large generalizations of science, founded upon wide abstractions and only partly relevant to any particular issue, provide the essential basis for all sociological reconstruction. To-day, the adventure of ideas is the discovery of opportunity, but the first requisite is that order be imposed. There can be no civilization apart from a well-organised system of inter-related activities, within which the intimacies of family life can be developed. The essence of the world-wide sociological problem is the study of the modes of grouping mankind subject to some co-ordination of the various groups.

But a stable order, though necessary, is not enough. There must be satisfaction for the purposes which are inherent in human life, and in this Prof. Whitehead's thought runs on similar lines to that of Sir John Orr. Suggesting further that beyond this the experiences which form the distinction between mankind and the animal world demand a social structure supplying freedom and opportunity for the realization of objectives beyond the simple bodily cravings, Prof. Whitehead thinks we are in the first phase of a third enlargement of opportunity through the introduction of new techniques, and the new crisis of civilization promises more fundamental change than any preceding advance. The whole human practical activity is in process of immediate transformation by novelties of organised knowledge, and the whole extent of learned thought is transforming every activity of mankind. Urging the importance of scientific men and historians working together, and stressing the danger of simple-minded generalizations of those going beyond their own limits of specialized knowledge, Prof. Whitehead distrusts any extreme abstract plan of universal social construction. Every successful advance is a compromise, and the general ideal is the wide diffusion of opportunity.

In the four years since Prof. Whitehead's paper was presented many things have happened to justify his argument; and while there is much in the United Nations Organisation that embodies the bitter experience and the hard lessons of the League of Nations, his warning against extremism and his insistence on the necessity of compromise should be heeded. A new instrument has been forged, but whether it is more effective than the old will depend on the wisdom and the spirit and the determination with which it is used. If the nations, and above all the great Powers, are sincere in their professions of a desire to co-operate, if they seek to understand one another's point of view, if there is full and free exchange of information, then it may well be hoped that the pursuit of such tasks as those to which the Food and Agricultural Organisation, the United

Nations Relief and Rehabilitation Administration and the Emergency Conference on European Cereals Supplies are addressing themselves equally with the Economic and Social Council, will strengthen the common interest in prosperity, the recognition that economic prosperity, like peace, is indivisible, and render more tractable the animosities and political problems which have already caused such concern to the new Organisation. But while it must be remembered that conceptions of democracies and of other political systems may vary widely in different countries, and no one political system is likely to serve the needs of all nations, there are certain principles which must be observed if any international association is to be possible. The United Nations Organisation is not, and cannot be made, a world government: it is at best an instrument of international co-operation. Even so, it cannot function except on a basis of mutual trust and the abandonment of the claim to be a judge in one's own cause. Full confidence can only come as the new instrument proves its worth, but the way forward lies in the full and public understanding of the way it functions and what it can and cannot do. There is no more urgent or more important step towards that end than full and free discussion in all countries by those who realize the importance of this new venture and the catastrophe which will overwhelm mankind if it fails.

[1] Third Montague Burton Lecture on International Relations: Victory and After. By Prof. Gilbert Murray. Pp. 16. (University of Leeds, 1945.) 6d.

[2] League of Nations. Report on the Work of the League during the War. (Official No. A.6. 1946.) Pp. 167. (Geneva: League of Nations. London: George Allen and Unwin, Ltd., 1945.) 2s.

[3] The United Nations Charter. (Peace Aims Pamphlet 31.) Pp. 56. (National Peace Council, 144 Southampton Row, London, W.C.1, 1946.) 1s.

[4] *Proceedings of the American Academy of Arts and Sciences*, 75, No. 1. Papers on Post-War Problems. Pp. 54. (Boston, Mass.: Amer. Acad. Arts and Sci., 1942.) 1.25 dollars.

ADVANCES IN CARBOHYDRATE CHEMISTRY

Advances in Carbohydrate Chemistry
Edited by W. W. Pigman and M. L. Wolfrom. Vol. 1. Pp. xii+374. (New York: Academic Press, Inc., 1945.) 6 dollars.

THE rapid increase in the volume of scientific publications makes it ever more difficult for those interested, specialists and non-specialists alike, to keep abreast of recent developments in any particular field. Many attempts have been made to solve this problem, one of the most recent taking the form of a series of volumes devoted to articles on specialist topics in one field of inquiry. In the circumstances, these serve a useful purpose, but it must be admitted that their acquisition is rapidly becoming a formidable financial problem both for libraries and for private individuals. The latest comer in this group is "Advances in Carbohydrate Chemistry", the first volume of which has just appeared under the supervision of an editorial board which includes both American and British representatives. The present volume, however, is entirely American in authorship, this being clearly a reflexion of war-time difficulties of writing and communication, and not an indication of the relative interest in carbohydrate chemistry in the two countries.

The eleven articles are in the main detailed reviews of the type made familiar to all chemists by *Chemical Reviews*. They are admirable of their kind, lucidly written and well illustrated by formulæ and equations. They are a veritable storehouse of historical and factual information, much of which is not readily accessible otherwise, and is in any event difficult to assemble. We can be grateful, therefore, to the experts who have given us these authoritative accounts of the historical development and the present position of knowledge in these special branches of carbohydrate chemistry.

It is very appropriate that the first article in this new venture should come from the pen of C. S. Hudson, whose contribution on "The Fischer Cyanohydrin Synthesis and Configurations of Higher Carbon Sugars and Alcohols" is one of the most interesting in the volume. To most readers it will be a surprise to realize how much detailed effort and skill have been devoted in the past half-century to the elucidation of the structures of the higher sugars and their derivatives, and how many problems still remain to be solved.

N. K. Richtmyer writes on "The Altrose Group of Substances". Until recently little was known about this group, which is of special interest because of its configurational relationship to ribose. Rapid progress is, however, being made in methods of preparation and in the detailed investigation of individual members of the group, which includes the naturally occurring ketose sedo-heptulose.

The interesting, and in many ways puzzling, group of "The Carbohydrate Orthoesters" is described in detail by E. Pacsu, who makes a gallant, but to the reviewer not altogether convincing, attempt to 'explain' the peculiar properties of these esters in terms of modern electronic theories of valency.

A. L. Raymond discusses the thio- and seleno-sugars, an interesting but comparatively little investigated group of substances concerning which much more is likely to be heard in the future. This article is followed by one on the "Carbohydrate Components of the Cardiac Glycosides" by R. C. Elderfield, who describes the occurrence, preparation and constitution of all the known simple sugars and of one of the disaccharides in this rare and complex but fascinating group of substances. A detailed account of the "Metabolism of the Sugar Alcohols and their Derivatives" is contributed by C. J. Carr and J. C. Krautz, and a masterly and readable article on the "Chemistry of the Nucleic Acids" is given by R. S. Tipson. In it he discusses the difficulties met with in the investigation of the desoxyribosylpurines and the isolation of 2-desoxyribose, and shows how the structures of the various nucleosides and nucleotides have been elucidated.

An article by T. J. Schoch on the "Fractionation of Starch" is particularly welcome in view of the prominent part this author has taken in recent work on the separation of the amylose and amylopectin components of starch, through which an entirely new chapter has been opened up in starch chemistry. There are articles on starch esters by R. L. Whistler and on "Cellulose Organic Esters" by C. R. Fordyce —mainly dealing with a summary account of methods of preparation and physical properties. The concluding section is by E. Anderson and Lila Sands on "A Discussion of Methods of Value in Research on Plant Polyuronides". These substances are among the most complex natural products known, and in this useful article a critical account is given of the

practical methods available for the isolation, purification and examination of various pectic materials, gums and mucilages.

It will be obvious from the brief description of the contents that the articles cover a wide field, and their publication will serve a most useful purpose. In some places observations hitherto unpublished are recorded, but it is to be hoped that the publication of original papers in this form will be resisted by the editorial board. There is a place for the regular publication of review articles in volumes of this type, but questions relating to indexing, to mention one aspect only, would become still more complex if these "Advances" became partly reviews and partly original material.

E. L. HIRST

THE FIRST NATIONAL PHARMACOPŒIA

Pharmacopoeia Londinensis of 1618

Reproduced in facsimile, with a Historical Introduction by George Urdang. (Hollister Pharmaceutical Library, No. 2.) Pp. ix + 299. (Madison, Wis.: State Historical Society of Wisconsin; New York: Schuman's, 1944.) 12 dollars.

IT is difficult to say when the first pharmacopœia was published. The first edition of the Chinese Materia Medica is said to have been prepared about 3000 B.C. by the emperor Shen Nung. The Ebers Papyrus was written about 1500 B.C. Books on materia medica were written by Theophrastus (380–286 B.C.), Scribonius Largus (A.D. 45), Dioscorides (c. A.D. 60), Galen (A.D. 130–200) and many others. It is sometimes said that the first real pharmacopœia was the "Nuovo Receptario Composito", which was made official in Florence in 1498, or the book prepared by Valerius Cordus which was adopted officially by Nuremburg (1546), or that prepared by Adolph Occo (1564) which was actually called a pharmacopœia and was made official in Augsburg in 1613.

These books were only 'official' in small territories. The Royal College of Physicians in London was the first body to prepare a pharmacopœia which became official throughout a whole country. The project was first discussed in 1585, and the College decided to think it over. Four years later the College discussed it again and decided to take action. A committee was appointed, and started work energetically; but though it was reinforced five years later, it did not complete its task. There was then a period of nearly twenty years during which little or nothing was done. In 1614 activity revived; a new committee was appointed which finished its work in four years and produced the first issue of the pharmacopœia in May 1618. Apparently only two copies of this issue are known to exist, and one of these has now been reproduced in facsimile. The actual text is preceded by 80 pages of most interesting historical discussion by Dr. George Urdang, who fled from Germany in 1939 and is now director of the American Institute of the History of Pharmacy, Madison.

This first issue evidently met with much criticism from the younger fellows of the Royal College of Physicians and was replaced in December 1618 by a larger book, which became accepted as the first edition. All the blame for the deficiencies of the first issue was laid on the printer: "As a blaze flares up from a fire and in a greedy famine deprives the stomach of its still unprepared food, so the printer snatched away from our hands this little work not yet finished off, without consulting the president, yea even during a time when the latter who most thoroughly took care of corrections and polishing was out of town because of a call". Dr. Urdang believes that the printer was merely a convenient scapegoat who took the blame for a fundamental change in the book. A detailed comparison of the two issues provides weighty evidence for this view. The first issue was a comparatively brief list of drugs and compounds in common use. The second issue was a combination of formulary and text-book with the purpose of giving general information and a survey of the entire materia medica. Its list of simples (crude drugs) was nearly twice as long. The names of three senior members of the College which had been attached to formulæ in the first issue were eliminated. The new list of fellows of the College contains more information about the professional distinctions of junior fellows. The production of the second issue was thus probably due to the desire of these junior fellows for a more learned and comprehensive book which would bring more credit to the College in general and to themselves in particular, and would include all the drugs which they themselves prescribed. The most striking increase was in the section devoted to organotherapy. Under the heading "Animalia" there are 47 items in the first issue and 162 in the second. The additions include the flesh of vipers, swallows' nests, feathers, saliva, sweat and five kinds of urine, none of which is official to-day; but they also include liver, stomach, and honey, which are. The new issue was clearly quite a new book, and the official reasons for the suppression of the first issue do not stand up to critical examination. The first issue was more like a modern pharmacopœia and, if it had survived, later committees would have been saved from much expurgation.

Apart from this discussion of the two issues, Dr. Urdang gives an interesting account of the historical background. Both issues were based on numerous previous formularies, of which the most directly important was the Augsburg pharmacopœia, which was reproduced as No. 1 of the Hollister Pharmaceutical Library. The preface addressed *candido lectori* is identical in both issues and makes entertaining reading. It is much more appropriate to the first issue than the second. It makes grateful reference to the learned and active King James who had just bestowed a royal charter on the Society of Apothecaries, and who authorized the inclusion of a royal proclamation in both issues forbidding apothecaries to use any other pharmacopœia. It emphasizes the desire of the Royal College of Physicians to include both old drugs and new: "Although we revere the wisdom of the old masters and have arrayed their preparations, so to speak, in the first line of battle, nevertheless we have not rejected or disdained the auxiliary troops of the new chemistry". The revolutionary views associated with the name of Paracelsus and his followers were thus officially recognized. The main purpose of the original committee was, however, to conduct a campaign against complicated prescriptions. This purpose was largely defeated by the publication of the second issue.

Dr. Urdang has done a great service in bringing these facts to light, and is to be congratulated on having produced a magnificent book.

J. H. GADDUM

Bird Photography

By G. K. Yeates. Pp. 114 + 48 plates. (London: Faber & Faber, Ltd., 1946.) 12*s.* 6*d.* net.

BIRD photography has now so many skilled devotees that to say Captain G. K. Yeates is among the best places him very high indeed, yet he certainly excels not only in securing subjects in happy and characteristic pose, but in the technical skill with which he renders bird and surroundings. In this book he has set forth in full and clear detail the conclusions at which he has arrived during many years work and experience, illustrating the whole with excellent reproductions of his fine pictures. The book will be read with profit and appreciation by all bird photographers, and will be invaluable to the beginner.

He discusses apparatus, hides, methods of work, and various types of work. His remarks on cameras should save the novice much cash and grief, for as he justly points out a good bird portrait at the nest can be better achieved with an old-fashioned stand camera than the most perfect of modern miniatures, though the latter is invaluable for flight snapshotting and such subjects. But on the lens, as he rightly insists, no photographer must economize. It is interesting to note that for all-round field work he prefers an 8½-in. lens. He points out that, though a telephoto lens has its uses, a bird photographer can do a vast amount of good work with one useful lens. On hides, too, Captain Yeates has much that is helpful to say, whether it be a plain, simple ground hide, or one aloft in a tree, in connexion with which he shows some especially good tree-top pictures, including a most excellent portrait of a brooding rook, reminding us of the work he did some years ago on the social behaviour and home life of the rook. May we suggest it is in such intensive study that bird photography will, in the future, be of greatest assistance to ornithology.

FRANCES PITT

Om Nordens, Främst Baltikums, Senkvartära Utveckling och Stenåldersbebyggelse

(On the Late Quaternary Development and the Stone Age Settlement of North Europe, primarily the Baltic.) Av Henr. Munthe. (Kungl. Svenska Vetenskapsakademiens Handlingar, Serien 3, Band 19, No. 1.) Pp. 242+16 plates. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1940.) n.p.

DR. MUNTHE is a distinguished geochronologist. He must be the doyen in his subject in Scandinavia. His first paper was published so long ago as 1886, and since that date few years have passed without some further contribution to knowledge appearing from his pen. The volume under notice presents the mature results of the author's work and conclusions on his subject. Scandinavian geochronology from the end of pleistocene times onwards is particularly complex and interesting. Not only was the region affected by the normal sequence of post-glacial climate changes, but there were also up and down movements of the land relative to the sea which have to be taken into account. Dr. Munthe's exposé is largely factual, and there is a wealth of information here collected, the results of his own and other people's investigations. The treatment of the stone age settlements is slighter. The author is interested in human cultures not so much in themselves as in how they correlate with the various climate phases with which he is concerned. There are plenty of illustrations, the descriptions of which are translated into English; there are also sixteen very important maps and diagrams in a folder at the end of the volume. The book as a whole is, of course, in Swedish. Dr. Munthe is to be congratulated on having produced such a clear and detailed account of his life's work and ideas.

M. C. BURKITT

A Home of Their Own

By K. E. Barlow. Pp. 96. (London: Faber and Faber, Ltd., 1946.) 4*s.* 6*d.* net.

DR. BARLOW is a physician practising in Coventry and here sets out to describe how a group of people in that devastated city have tried to seize opportunity by the forelock in developing a venture similar to the now famous Peckham Health Experiment.

With the belief that "if living is to be made understandable through science, the role of the home in the life of society must be clearly understood", this group decided to form a Family Health Club. The *motif* of the club was to allow the residents on a housing estate to develop their neighbourhood with some such unit like the Peckham Health Centre as focus. In this book, little is said of the organisation of the club, and details are also scanty about the response of the tenants whose co-operation was invited; evaluation of the experiment must therefore await more information.

Most of the account is made up of Barlow's dissertations about the function of the home in society and contains much sound thinking and advice. Unfortunately, the author's enthusiasm loosens the brakes of control and, in his onward rush, releases much that is superficial and unsubstantiated. If he could be persuaded to condense this book to a quarter of its present size by eliminating loose writing and meretricious argument, he would make a contribution to sociological thought which would be timely and useful.

T. H. H.

Chemical Industries

Edited by L. Ivanovszky. Twentieth edition, enlarged and revised. Pp. xxviii + 394. (London: Leonard Hill, Ltd., 1946.) 15*s.*

MEETING this compilation for the first time, the reviewer was at once impressed by the great amount of information it contains and somewhat disappointed by the mode of presentation. Evidently its present form has been acquired by evolution through recent editions; but it would appear that some of the individual glossaries could be combined, with a net gain to the convenience of the user: such are, for example, "Constructional Materials" and "Chemical Plant"; and "Industrial Chemicals", "Fine Chemicals", "Pharmaceuticals" and "Perfumery Raw Materials". This suggestion would seem to have added force because of the great number of trade-names of products which the glossaries contain—a feature contributing greatly to their usefulness. It must, however, be admitted that the 22-page "Index to Technical Data" covering all the glossaries and the intervening articles goes far to provide a simple alternative: it survived all tests the reviewer could apply.

The text has evidently been carefully prepared and shows few misprints (among which, however, are to be found references to the "shakeproof" instead of "shockproof" leads and shields of modern X-ray tubes). The book is well produced, and should be a useful work of reference for industrial chemists.

CONTROL OF ATOMIC ENERGY

THE academic study of nuclear physics has led to the release of nuclear energy and to the atomic bomb. Britain and the United States together agreed to use the new weapon against the cities of Japan. They are now preoccupied with the problem of how to prevent this diabolic agent of destruction from ever again being used, either against themselves or against any other peace-loving nation, while at the same time preserving some opportunity for the development and possible exploitation of its peaceful uses.

The unprecedented rapidity of this translation of an academic discovery into the most powerful agent of military tactics has insured that the drive and interest of scientific men, particularly those engaged in the final stages of its preparation, should be turned naturally to the consideration of the ticklish technical and political problems of its control. Through the public activities of the Committee of Atomic Scientists of the United States, later amalgamated into the Federation of American Scientists, the subject received such wide interest through the Press and radio of the world that the original proposals for legislation in the United States for the control of nuclear energy by a primarily military organisation were defeated. There can be little doubt that the activity of men of science in the United States and the United Kingdom hastened, if it did not initiate, the meeting between Mr. Attlee, Mr. Truman and Mr. Mackenzie King, which originated the proposal that the United Nations Organisation should establish a commission to consider the problem. The early and united stand made by the American scientific workers has affected profoundly all thinking about atomic energy, and the many constructive proposals made by them about international control, and the pre-requisite of free dissemination of scientific information, have reacted strongly on those responsible for the framing of national legislations.

The care with which the State Department of the United States has considered the far-reaching implications of atomic energy is evident from the document before us*. The mode of its preparation is an interesting example of the profound differences which are sometimes to be found between the working of democracy in the United States and in Great Britain. In order that the American representative on the Atomic Energy Commission of the United Nations Organisation should be properly briefed, a committee was set up "to study the subject of controls and safeguards necessary to protect this Government, so that the person hereafter selected to represent the United States on the Commission can have the benefit of the study". This committee consisted of Mr. Dean Acheson, Drs. Bush and Conant, Major-General L. R. Groves, who was administratively responsible for the whole atomic bomb project in the United States, and Mr. J. J. McCloy. At the first meeting in January it was "agreed that it was first essential to have a report prepared analysing and appraising all the relevant facts and formulating proposals". Preparation of this report was entrusted to "men of recognized attainments and varied background, who would be prepared to devote the major part of their time to the matter". This board consisted of Mr. D. E. Lilienthal, chairman of the Tennessee Valley Authority, who acted as chairman, Mr. C. I. Barnard, Dr. C. A. Thomas, and Mr. Harry A. Winne, all technical executives of private industrial concerns, and Dr. J. R. Oppenheimer, professor of theoretical physics in the California Institute of Technology, who was in charge of the Los Alamos section of the atomic bomb project. Throughout the report signed by the Board, acknowledgment is made to innumerable scientific and industrial men who were consulted, and whose opinions were available. The result is a report of the highest importance, which may well serve as a model for British efforts to formulate corresponding proposals for consideration by the Atomic Energy Commission of the United Nations Organisation.

It is natural that such proposals should be coloured primarily by the dangers to which the development of methods of mass destruction exposes the United States of America, and it is probable that other countries would give somewhat different emphasis to the issues raised. The primary conception is the separation of the various aspects of atomic energy into processes which are 'dangerous' in that they could be steps in a national move to make atomic weapons, and processes which are 'safe', or which can be carried on with negligible risk that they can be converted quickly to warlike purposes. The 'dangerous' operations are to be the prerogative of the United Nations Organisation, the 'safe' being allowed to individual nations and to industry under proper safeguards. The prime 'dangerous' operations are the mining or acquisition of sources of fissile materials, principally uranium, and the preparation from them of concentrates suitable for the production of bombs. The limited occurrence of rich ores and the size of plant for dealing with low-grade ores, or for separation of isotopes or preparation of plutonium, are factors rendering it comparatively easy to detect evasion of these restrictions. 'Denatured' materials, presumably uranium 235 and plutonium mixed with isotopic material which is difficult to separate without major plant, would be supplied for the exploitation, under licence, of atomic power for peaceful purpose, for the preparation of artificial radioactive 'tracer' elements, for experimental purposes and for the preparation of powerful neutron sources. This 'denatured' material could not be used, on present knowledge, for the preparation of atomic bombs. Any attempt to separate it from the denaturing body would be a serious infringement of regulations to be prepared by the United Nations Organisation.

An important feature of the proposals is that a comparatively few specified operations are to be declared illegal, and infringement of any one of these restrictions would be complete evidence of war-like intent. There would be no necessity to prove that an infringing authority had evil intentions. This would serve greatly to simplify procedure by the United Nations authority, and indeed lifts the basis for international action from the cumbrous sphere of theoretical law to the simple proof of the carrying out of a physical process.

The interim period before the Atomic Energy Commission of the United Nations Organisation can take over the complete supervision of atomic energy, and during which America continues to possess a complete monopoly of all actual plants capable of preparing atomic bombs, and of the majority of information on technical knowledge, as well as of some strictly scientific but essential information, is the critical period in which the proposals, if implemented, are likely to meet greatest difficulty. The problem

* A Report on the International Control of Atomic Energy. Prepared for the Secretary of State's Committee on Atomic Energy by a Board of Consultants, Washington, D.C. Pp. viii + 44. (Washington, D.C.: Government Printing Office; London: H.M. Stationery Office, 1946.) 1s. net.

of reconciling a proper care for the security of the United States with essential handing over of information to the new body is solved in a manner which is eminently reasonable from the American point of view, but which may not seem so free from danger to the U.S.S.R. If other countries are prepared to accept the avowed intention of the United States to preserve a proper regard for the interests of all nations until such time as her trusteeship of what is admittedly an ephemeral possession of a unique weapon can be handed over to the United Nations Organisation, all will be well. The danger lies in international tensions over peace treaties, bases, or economic problems of trade, which might precipitate crises aggravated by the unilateral possession of the new weapon of destruction. From the technical point of view the suggested action seems very reasonable, and the system of control would work if proper provision is made for the fact that new discoveries may alter profoundly the basis of the proposals. There runs through the whole report a spirit of optimism which is highly infectious, and it is necessary to remember that confidence in complete physical understanding and knowledge has often been upset in the past by further scientific investigation. The great weight of technical skill and opinion embodied in the proposals renders it improbable that further knowledge will invalidate them in the near future, but allowance must be made for such an eventuality.

Consideration of these valuable proposals should be tempered by the realization that other countries, which are short of coal and other sources of power, may be more directly interested in the peaceful production of power by atomic methods than is the United States, which is so richly endowed by Nature. The suggestion that the handing over to the United Nations Organisation of information and executive power in atomic energy should take place by stages, and rather slowly, may result in an atomic arms race during the period of trusteeship by the United States. If promptly acted upon, these proposals could save the world. If political dilatoriness and self-seeking lead to stalling tactics and lack of agreement, they may have precisely the opposite results.

M. L. OLIPHANT

AN ESTIMATE OF THE AGE OF THE EARTH

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EVER since the publication by Nier and his co-workers[1] of the relative abundances of the isotopes in twenty-five samples of lead from common lead minerals of various geological ages (Table 1), I have entertained the hope that from these precise data it might be possible to fathom the depths of geological time. The calculations involved are, however, somewhat formidable, and a systematic investigation became possible only recently, with the acquisition of a calculating machine, for which grateful acknowledgment is made to the Moray Endowment Research Fund of the University of Edinburgh. The results have fully justified expectation and indicate that the age of the earth, reckoned from the time when radiogenic lead first began to accumulate in earth-materials, is of the order 3,000 million years.

In his first paper, Nier pointed out that those samples of lead "which contain relatively more Pb^{206} also contain relatively more Pb^{207} and Pb^{208}". The abundances of these isotopes, listed in Table 1, are all relative to $Pb^{204} = 1$. Since Pb^{204} is not generated by any naturally radioactive element, it can be taken as an invariable constituent of the *primeval lead* occurring in the earth at the time of the earth's origin. Calling the lead with the lowest relative abundances (No. 19) "the least contaminated lead", Nier suggested that all the other samples could be regarded as made up of this "least contaminated lead" plus additions of Pb^{206} and Pb^{207} generated from uranium, and of Pb^{208} generated from thorium. The minerals from which the samples of lead were extracted are all essentially free from radioactive elements, and hence the excess isotopes must have been generated before the minerals were formed. This point is, of course, of fundamental importance. It can easily be calculated that if the excess isotopes in the Joplin leads (Nos. 9–11) had been formed in the ore itself, the necessary amounts of the radioactive elements would have been 6·2 gm. U I, 24 gm. AcU and 20 gm. Th per gm. of galena—impossible amounts, hundreds of millions of times greater than any actual traces that may locally be present. Post-deposition contamination of lead being thus completely ruled out, it follows that before its concentration in ores, the lead must have been

TABLE 1. ISOTOPIC ABUNDANCES ($Pb^{204} = 1$) OF LEAD (NIER *et al.*) FROM MINERALS OF VARIOUS AGES.

No.	Source of lead, locality and geological age of ore deposit	Pb^{206}	Pb^{207}	Pb^{208}	Total (incl. $Pb^{204} = 1$)	Pb^{208}/Pb^{206}
1	Galena (2)*, Casapalca Mine, Peru. Late Tertiary, 25 m.y.	18·85	15·66	38·63	74·14	0·831
2	Bournonite (2), Casapalca Mine, Peru. Late Tertiary, 25 m.y.	18·67	15·45	38·15	73·27	0·828
3	Wulfenite and Vanadinite, Tucson Mts., Arizona. Miocene, 25 m.y.	18·40	15·53	38·1	73·03	0·832
4	Galena, Sonora, Castle Dome, Arizona. Tertiary, 25 m.y.	19·22	16·17	39·15	75·54	0·841
5	Galena, Freiberg, Saxony. Tertiary, 25 m.y.	18·07	15·40	38·0	72·47	0·833
6	Galena and Anglesite, Durango, Mexico. Tertiary, 25 m.y.	18·71	15·70	38·5	73·91	0·839
7	Galena, Metaline Falls, Washington. Laramide, 60 m.y.	19·30	15·73	39·5	75·53	0·815
8	Cerussite (2), Wallace, Idaho. Laramide, 60 m.y.	16·04	15·11	35·26	67·41	0·942
9	Galena I, Joplin, Missouri. Late Mid. Cretaceous, 100 m.y.	21·65	15·88	40·8	79·33	0·733
10	Galena II (4), Joplin. Late Mid. Cretaceous, 100 m.y.	21·65	15·74	40·36	78·75	0·727
11	Galena III (4), Joplin. Late Mid. Cretaceous, 100 m.y.	22·38	16·15	41·63	81·16	0·722
12	Galena in Dolomite, Austria. Triassic, 175 m.y.	17·75	16·21	38·05	73·01	0·913
13	Galena, Nassau. Late Carboniferous/Early Permian, 220 m.y.	18·10	15·57	37·85	72·52	0·860
14	Galena, Eifel. Carb./Permian, 220 m.y.	18·20	15·46	37·7	72·36	0·850
15	Galena, Saxony. Carb./Permian, 220 m.y.	17·36	15·46	37·38	71·20	0·890
16	Galena, Clausthal, Harz Mts. Carb./Permian, 220 m.y.	18·46	15·66	38·6	73·72	0·848
17	Galena, Przibram, Bohemia. Carb./Permian, 220 m.y.	17·95	15·57	37·9	72·42	0·868
18	Galena, Yancey Co., N. Carolina. Late Carboniferous, 220 m.y.	18·43	15·61	38·2	73·24	0·847
19	Galena (2), Ivigtut, Greenland. Late Pre-Cambrian, 600 m.y.	14·65	14·65	34·48	64·78	1·000
20	Galena, Franklin, New Jersey. Pre-Cambrian (—)	17·15	15·45	36·53	70·13	0·901
21	Galena, Tetreault Mine, Quebec. Pre-Cambrian, 800 m.y.	16·27	15·16	35·60	68·03	0·932
22	Galena, Broken Hill, N.S. Wales. Pre-Cambrian, 1,200 m.y.	16·07	15·40	35·5	67·97	0·958
23	Cerussite, Broken Hill, N.S. Wales. Pre-Cambrian, 1,200 m.y.	15·93	15·29	35·25	67·47	0·960
24	Native Lead, Långban, Sweden. Pre-Cambrian (—)	15·83	15·45	35·60	67·88	0·976
25	Galena, Great Bear Lake, Canada. Pre-Cambrian, 1,330 m.y.	15·93	15·30	35·3	67·47	0·960

* Numbers in brackets indicate the number of determinations made. In all such cases the results closely agreed and the average figures are those here given.

dispersed through radioactive source-materials in which the primeval lead was slowly modified by additions of radiogenic lead. Calculation of the requisite amounts of uranium and thorium (relative to the lead in common rocks) indicates that the source materials could have been any of the common crustal rocks, granitic types and their derivatives being the most probable in most cases.

Several years ago[2], I showed, using the data then available on the uranium, thorium and lead contents of rocks, that the atomic weights of ore-lead derived from granitic or basaltic sources should vary with the age of the ore in accordance with the varied proportions of Pb^{206}, Pb^{207} and Pb^{208} generated in the source-rocks up to the time when the lead ore was formed. Since the recorded atomic weights of lead from ores of widely different ages failed to show the expected variation with time, it was inferred that ore-lead could not have come from granitic or basaltic sources. This inference must now be withdrawn, not only because Nier's work shows that the isotopic constitutions and the resultant atomic weights do, in fact, vary with time, but also because the data for uranium and thorium in rocks on which I relied have since been shown to be misleading[3]. Nier and his collaborators[1] have already pointed out that their results "are not in disagreement with the theory that ore-lead has its origin in the igneous rocks or magmas of these rocks". Allowing for certain subsidiary possibilities, such as the upward migration of primeval or 'old' lead from deeper sources, and the probability that some sedimentary leads (for example, No. 12) may be of marine origin, I am in complete accord with Nier's conclusion, which is, indeed, fundamental to the present study of some of the further implications of his work.

Fig. 1, in which the relationships between the data of Table 1 are graphically displayed, clearly shows that, with a few minor irregularities, Pb^{206}, Pb^{207} and Pb^{208} vary systematically among themselves and with the totals of the isotopic abundances. I, I' and I'' represent the results for the "least contaminated lead" (Ivigtut, No. 19), and J, J' and J'' those for the lead with the highest abundances (Joplin III, No. 11). Assuming provisionally that lead of the J type has evolved from lead of the I type by radiogenic additions, it is possible to construct curves I–J, I'–J' and I''–J'' showing the gradual changes in the abundances of the respective isotopes which would be brought about by the presence of appropriate amounts of uranium and thorium in the source-rocks. The derivation of these curves is illustrated by Fig. 2. The curve RIJ represents the cumulative growth of Pb^{206} during the last few thousands of millions of years within, say, 1 gm. of a source now containing 1×10^{-6} gm. uranium. $RI'J'$ represents the corresponding increase of Pb^{207}. The relative positions of the two curves can be fixed by the following considerations:

(*a*) The age, t_m, of the Joplin ores is about 100 m.y.[4].
(*b*) $Pb^{206} = Pb^{207}$ in lead of Ivigtut constitution, whence it follows that the curves must cross at a point $I = I'$.
(*c*) The position of I must be such that the ratio UJ'/UJ = excess Pb^{207}/excess Pb^{206} in Joplin III lead, which ratio is found to be 0·194 from the following data:

Lead	Pb^{204}	Pb^{206}	Pb^{207}	Pb^{208}
Joplin III (11)	1	22·38	16·15	41·63
Ivigtut (19)	1	14·65	14·65	34·48
Excess isotopes in Joplin III	–	7·73	1·50	7·15

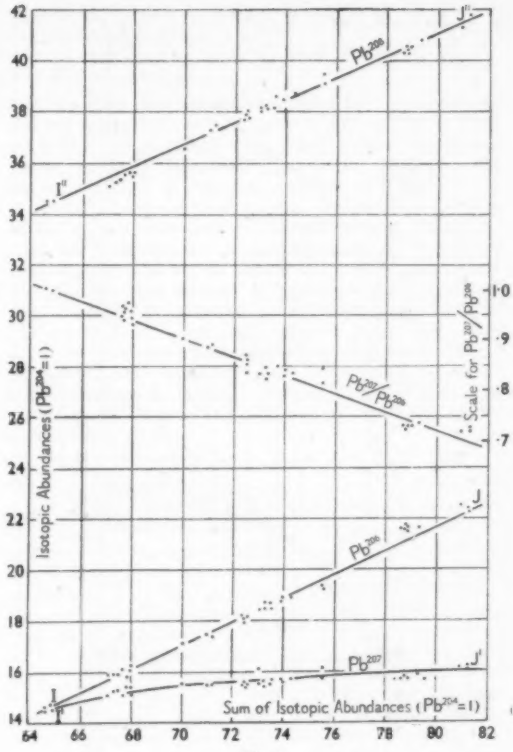

Fig. 1.

The time t corresponding to I can be found by trial; for it must be such that, in lead generated from a given amount of uranium,

$$\frac{Pb^{207} \text{ generated from } t \text{ to } t_m}{Pb^{206} \text{ generated from } t \text{ to } t_m} = 0{\cdot}194.$$

The value of t that gives this ratio when $t_m = 100$ m.y. is 2,760 m.y. The positions of I and the two curves being now determined against an arbitrary vertical scale, the latter can be readily transformed into one of isotopic abundances, since U, J' and J are also fixed, and we know that the point $U = 14{\cdot}65$, $J' = 16{\cdot}15$ and $J = 22{\cdot}38$. Completing the vertical scale of Fig. 2, the corresponding points for Pb^{208} can be inserted, since $T = 34{\cdot}48$ and $J'' = 41{\cdot}63$. I'' is necessarily vertically above I. The resulting curve $I''J''$ coincides exactly with that representing the cumulative growth of Pb^{208} in 1 gm. of a source now containing $3{\cdot}17 \times 10^{-6}$ gm. thorium; that is, the present value of the ratio of thorium to uranium in the source material of Joplin III lead would be 3·17. The latest estimates of this ratio from direct determinations are about 3·4 for granitic rocks and 3·3 for basaltic rocks[3].

From the data employed in constructing Fig. 2, the very similar curves IJ, $I'J'$ and $I''J''$ are added to Fig. 1, with isotopic abundances as abscissæ instead of time. It will be seen that they are very nearly the best curves that could be drawn through the points plotted. This coincidence demonstrates that the excess isotopes are essentially of radioactive origin; and that in the source-materials the average values of the ratio lead/uranium have been every-

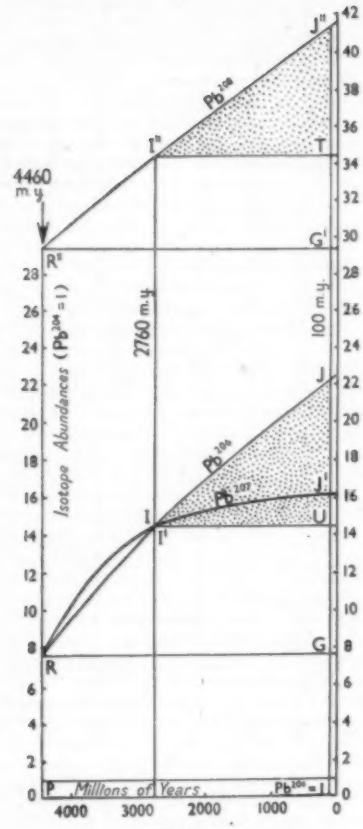

Fig. 2.

where nearly the same at any given time, as also have been the average values of thorium/uranium. It is obvious, moreover, that in the course of its evolution the Joplin III lead must have passed through a stage at which Pb^{206} was equal to Pb^{207} and that the point representing this stage cannot be far from I and I'.

The continuation of the curves for Pb^{206} and Pb^{207} beyond I and I' in Fig. 2 brings them to a point R, at $t = 4{,}460$ m.y., where they again coincide. This corresponds to the time at which, on the assumptions made concerning Joplin lead, U I and AcU first began to disintegrate. The age of the earth must therefore lie between the approximate limits of 2,760 m.y. and 4,460 m.y. Similarly, the constitution of the primeval lead must fall between the approximate limits determined by the ordinates of R and I, and R' and I'.

Primeval lead	Pb^{204}	Pb^{206}	Pb^{207}	Pb^{208}	Pb^{206}/Pb^{204}
Upper limit, at $t = 2{,}760$ m.y.	1	14·65	14·65	34·48	1
Real values (to be determined)	1	x	y	z	>1
Lower limit, at $t = 4{,}460$ m.y.	1	7·8	7·8	29·5	1

Inspection of Figs. 1 and 2 shows that it would be possible to construct similar curves through the points representing any given pair of lead samples with a suitable difference in age and constitution. The curves for different pairs would in general have different vertical scales, but ideally the various sets of curves for Pb^{206} should all pass through the point x on the corresponding scales, and those for Pb^{207} should pass through y. This consideration suggests a method for determining x and y and the corresponding value of t_0, the age of the earth. Using the following symbols, with t_m for the age of the lead ore,

	Pb^{204}	Pb^{206}	Pb^{207}	Pb^{208}
Ore-lead (= source-lead)	1	a	b	c
Primeval lead	1	x	y	z
Radiogenic lead (from t_0 to t_m)	—	$a - x$	$b - y$	$c - z$

we have :

$$\frac{b-y}{a-x} = r = \frac{Pb^{207} \text{ generated by 1 gm. U from } t_0 \text{ to } t_m}{Pb^{206} \text{ generated by 1 gm. U from } t_0 \text{ to } t_m}.$$

Preliminary tests having shown that t_0 is within the range 2,760–3,100 m.y., r can be systematically computed for various values of t_0, such as 2,760, 2,900, 3,000 and 3,100 m.y. For each assigned value of t_0 we have :

$$ar - xr = b - y \text{ for one sample of lead, and}$$
$$a'r' - xr' = b' - y \text{ for another sample ;}$$

$$\text{whence, } x = \frac{b - b' + a'r' - ar}{r' - r}; \quad y = b + rx - ar.$$

By plotting x and y against time, two converging lines are obtained. Taking another pair and constructing the corresponding lines, it is then possible to find graphically the value for t_0 at which the respective values for x and y coincide or most nearly coincide. The method is very sensitive to small variations in the data, and it is therefore the more remarkable that in a fair proportion of combinations the value for t_0 where the x-lines cross is almost exactly the same as that given by the intersection of the y-lines. When the two values for t_0 differ appreciably, their average is taken. In some combinations the x-lines (and/or the y-lines) are coincident or parallel and no result is possible. The following examples illustrate the method and the range of results obtained :

	PAIR *A*		PAIR *B*	
	Broken Hill (23)—Joplin (11)		Broken Hill (23)—Tucson (3)	
$t_0 = 3{,}100$ m.y.				
r	0·3106	0·2385	0·3106	0·2349
ar	4·948	5·338	4·948	4·332
x	11·37		11·44	
y	13·87		13·89	
$t_0 = 3{,}000$ m.y.				
r	0·2939	0·2244	0·2939	0·2209
ar	4·682	5·023	4·682	4·065
x	12·50		11·74	
y	14·32		14·06	

The solutions for the above combination are listed below, together with the results from a few other combinations of pair *A* with other pairs.

Combination of Pair *A* with	t_0 (m.y.)		x	y
Pair *B*, Broken Hill (23)—Tucson (3)	3090	*A*	11·48	13·91
		B	11·47	13·91
Pair *C*, (23)—Peru (2)	3040	*A*	12·03	14·17
		C	11·98	14·11
Pair *D*, (23)—Nassau (13)	3000	*A*	12·50	14·32
		D	12·48	14·28
Pair *E*, (23)—Clausthal (16)	2995	*A*	12·56	14·34
		E	12·61	14·32
Pair *F*, (23)—Mexico (6)	2915	*A*	13·54	14·62
		F	13·52	14·61

The average result of eleven such combinations with Broken Hill (23) in common is $t_0 = 2{,}990$ m.y.

As already mentioned, some of the combinations fail to give results. This brings out the important fact that not all the samples of lead can be regarded as 'normal' in the sense of being products of continuous contamination in a single source. For example, a lead ore might be due to concentrations of rock-lead plus lead from older ore deposits which became involved in the cycle of magmatic or geochemical activity responsible for the lead ore in question. In such a case the total of the isotopic abundances would be

less than the normal figure for the age of the ore, the ratio total Pb^{207}/total Pb^{206} would be greatly increased, and the ratio radiogenic Pb^{207}/radiogenic Pb^{206} would also be increased. The lead samples of Idaho (8) and Saxony (15) show these peculiarities. Again, a lead ore might come from a source to which additions of the radioactive elements had been made at some time after the origin of the source but before the date of ore formation; or from a source from which radiogenic lead became concentrated in a higher proportion than primeval lead. In both these cases the total abundances would be increased, while the ratios mentioned above would be decreased. The Joplin leads (9–11) reveal these peculiarities very strikingly, though Joplin III is more nearly normal than the other two. Ivigtut (19) and, to a less degree, Tetreault (21) show similar abnormalities, but with modifications that are probably to be referred to a low uranium content in the source. The Austrian sedimentary lead (12) has so high an abundance of Pb^{207} that it must have had an entirely different kind of origin from all the other samples investigated. A marine origin, with selective concentration of Pb^{207} by organic intervention, may be provisionally suggested. Rejecting all the 'suspect' samples (and those for which a numerical age cannot at present be estimated) leaves us with those listed in Table 3.

From the Broken Hill (23) series of results already exemplified, and also from two similar series with Broken Hill (22) and Great Bear Lake (25) respectively in common, all the suspect samples except Joplin III were omitted. Finally, a series was worked out from all the possible combinations of the normal samples (that is, excluding Joplin III). The average solutions, together with the average solutions for a series from which the suspect samples were not excluded, are listed in Table 2.

TABLE 2.

Series of combinations	Number of good combinations	x	y	t_0	Range of t_0
General (including suspect samples)	27 (incomplete)	12·00	14·20	2950	2700–3150
Broken Hill (22) in common (including Joplin III)	14	11·45	14·06	2960	2760–3140
Broken Hill (23) in common (including Joplin III)	11	12·41	14·29	2990	2900–3090
Great Bear Lake (25) in common (including Joplin III)	7	12·58	14·28	3025	2900–3125
Normal samples only (excluding Joplin III)	13	12·52	14·29	3015	2725–3150

It is of interest to notice that the values for t_0 vary less widely than those for x and y, and that the value for t_0 derived from the first series differs but slightly from the last result, which is probably to be regarded as the best. It may be concluded with a high degree of probability that the age of the earth is not far from 3,000 m.y. Adopting this estimate, the corresponding values for x and y are 12·50 and 14·28.

From these values the abundance of Pb^{206} in primeval lead (z) and the present-day value of the ratio thorium/uranium in the source materials can now be approximately determined. Writing p for the ratio thorium/uranium, we have, for any sample of lead:

$$\frac{c-z}{a+b-x-y} =$$

Pb^{206} generated by 1 gm. Th (now) from t_0 to t_m / Pb^{206} + Pb^{207} gen. by 1 gm. U (now) from t_0 to t_m × Th/U = Rp (R being calculable for the interval concerned).

Hence, $c - z = Rp(a + b - x - y)$

for one sample of lead, and

$$c' - z = R'p(a' + b' - x' - y')$$

for another sample.

Solving for p and z in 24 successive pairs, the average values are found to be $z = 31{\cdot}82$ and $p = \text{Th/U} = 3{\cdot}83$ (with a range from 2·5 to 5·2). In granitic rocks recently analysed for both uranium and thorium[3], Th/U is found to average about 3·4.

An approximate average for the uranium content of the source materials of the various samples of lead can be arrived at by transforming the relative abundances into actual amounts of lead. The latest work on the lead content of granitic rocks[6,7] indicates that the older average of Hevesy and Hobbie[6] (Pb = 30 × 10^{-6} gm./gm.) is too high, and that 20 × 10^{-6} is a more probable value. Goldschmidt and Hörmann[8] find the same figure to be characteristic of sandstones and shales. Taking the total of the abundances for late Tertiary lead (Table 1) as 74, we can write

$$74n = 20 \times 10^{-6}; \text{ whence } n = 0{\cdot}27 \times 10^{-6}.$$

The amount of Pb^{206} generated by the uranium I in 1 gm. of source-rock from t_0 to t_m is then given by $(a - x) \times 0{\cdot}27 \times 10^{-6}$. The present amount of uranium I in the source (assuming it to be granitic) is found by dividing this amount of Pb^{206} by the amount generated by 1 gm. uranium I (now) from t_0 to t_m. The results are tabulated in Table 3. The average content of uranium I (= 0·993 uranium) is 3·23 × 10^{-6}, which corresponds well with the average uranium data for actual granites. Recent analyses give 2·77 × 10^{-6} (Keevil[10], 1938), 3·82 × 10^{-6} (Evans and Goodman[3], 1941) and 3·35 (Keevil[3], 1944). Almost equally consistent results are found by assuming a basaltic source with Pb = 5 × 10^{-6} gm./gm.[4,5]; uranium then is equal to 0·81 × 10^{-6}, against an actual average of 0·88 × 10^{-6} (Evans and Goodman[3] and Keevil[3]). However, neither field associations nor the lead contents of basaltic rocks favour a basaltic source for lead ores. The results are internally consistent with the inference that the granitic rocks and their derivatives are the main source of lead ores. There are reasons for suspecting that the Joplin ores may have had an ultrabasic source, but this possible exception need not be discussed here.

TABLE 3.

Lead samples	Excess Pb^{207} $(a-x)$	$n(a-x)$ × 10^{-6}	Pb^{206} from 1 gm. UI	$n(a-x)$* / Pb^{206} from 1 gm. UI
Peru (1)	6·35	1·71	0·49905	3·43 × 10^{-6}
Tucson (3)	5·90	1·59	,,	3·19
Mexico (6)	6·21	1·68	,,	3·37
Metaline Falls (7)	6·80	1·84	0·49438	3·72
Nassau (13)	5·60	1·51	0·47278	3·19
Clausthal (16)	5·96	1·61	,,	3·41
Bohemia (17)	5·45	1·47	,,	3·11
N. Carolina (18)	5·93	1·60	,,	3·39
Broken Hill (22)	3·57	0·96	0·32778	2·93
Broken Hill (23)	3·43	0·93	,,	2·84
Great Bear Lake (25)	3·43	0·93	0·30755	3·03

* The last column gives the amount of UI per gm. of source-rock, assuming that the latter contains 20 × 10^{-6} gm./gm. of lead; and that n = 0·27 × 10^{-6} and x = 12·5.

The results of the analysis of Nier's isotopic abundances summarized in this preliminary announcement depend, of course, on the accuracy of the data in Table 1 and of the disintegration constants adopted in the calculations:

$\lambda_{UI} = 1{\cdot}52 \times 10^{-10}$/year; $\lambda_{AcU} = 9{\cdot}72 \times 10^{-10}$/year; and $\lambda_{Th} = 4{\cdot}99 \times 10^{-11}$/year. Adopting these figures, and assuming that the 'normal' samples of

ore-lead are concentrations of rock-lead, it is shown that the age of the earth is not far from 3,000 m.y.; that corresponding to an age of exactly 3,000 m.y. the constitution of the earth's primeval lead is about

Pb^{204}	Pb^{206}	Pb^{207}	Pb^{208}
1	12·50	14·28	31·82

and that the most probable sources of ore-lead (with the provisional exception of the Joplin ores) are granitic rocks now containing, on average, about $3·3 \times 10^{-6}$ gm./gm. uranium, with the ratio thorium/uranium about 3·8. It is hoped to publish a detailed account of the investigation elsewhere.

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INDUSTRY AND RESEARCH

ON a number of occasions during the past year or two, the subject of research in industry in Britain has been ventilated and discussed at conferences arranged by various organisations. Although the attendance at these conferences has included some industrialists it is, to some extent, true that the discussions have been directed at industry; and that the general background of the conferences has included an assumption that industry had yet to be fully convinced of the virtues of applied science and that the vital relation between scientific research and industrial progress had yet to be completely appreciated. It was, therefore, fitting and timely that at a conference arranged by the Federation of British Industries held in the Kingsway Hall, London, on March 27 and 28, 1946, industry should have been given the opportunity of expressing its own views on this subject and of indicating the extent of its appreciation of the importance of scientific research. The conference was remarkable in that no less than twelve hundred delegates, drawn from all branches of industry, accepted invitations to attend it, and the Federation is to be congratulated on this successful outcome of its venture. Even more solid grounds for congratulation to the organisers, and to Sir William Larke in particular, were provided by the genuinely enthusiastic atmosphere and by the relevant and lively nature of the discussions which the conference evoked. There can no longer be any room for doubt as to the interest of industrialists in research.

The chairmanship of each of the four sessions of the conference was significant. At the introductory session on "Science, Industry, and the Community", the presence in the chair of Sir Clive Baillieu, president of the Federation of British Industries, provided an indication that this was a conference of industrialists. In passing it may be remarked that the opening of the discussion at this session by Sir Robert Robinson, president of the Royal Society, was symbolic of the complete dependence of the industrial application of science on the successful prosecution of fundamental, academic research. The Government's interest in industrial production was indicated by the presence of Mr. John Wilmot, Minister of Supply and Aircraft Production, at the second session, at which "Scientific Research and Production" was considered. The Minister of Supply shares with the President of the Board of Trade responsibility for the 'health of industry' in Great Britain. Further, the Government's realization of the need for adequate research was exemplified by the chairmanship of the Lord President of the Council, Mr. Herbert Morrison, at the third session, on "Scientific Research and Expansion"; his presence served as a reminder that the channel through which the benefits of the Government's practical interest may reach industry is provided by the Department of Scientific and Industrial Research. Finally, the continuity of Government policy in this matter was illustrated by the chairmanship at the fourth session, on "The Application of Research in Industry", of Sir John Anderson, formerly Chancellor of the Exchequer.

It will be convenient to review the conference under four heads provided by the resolutions submitted by Sir William Larke in his concluding address:

(1) "This conference recognizes that to ensure a reasonable standard of living the competitive power of British Industry must be firmly secured. To achieve this object it is essential to maintain technical pre-eminence in design, quality and production. This conference therefore urges every industrial concern to make the greatest possible use of scientific knowledge directly it becomes available."

The experience gained during the War of the amazing effect which a planned and co-ordinated scientific effort can have, not only on the volume of production but also on the ability to produce articles which exactly meet the requirements of the user, has been the most potent factor in spreading the gospel of the efficacy of applied research, and in this respect has created a conviction which innumerable conferences would never have achieved. The effects of the War on the industrial position of Britain have, however, been such as to make the translation of belief into concrete action a matter of desperate urgency and to render useless any slow and gradual introduction of science into the industrial framework.

There are many large industrial concerns with well-established comprehensive research departments, and the conference was given the benefit of the experience gained by the heads of some of these departments concerning the impact of research on the matters covered by the resolution. Exported goods, and, for that matter, goods for home consumption, must be of the highest quality. The use of the best and most suitable materials is vital to quality; hence research into the properties of materials, side by side with the search for new materials having particular properties, must be continuously pursued. Competitive power is dependent on maintaining low production costs. It is a fallacy that the empiricism and the trial-and-error methods of non-technical staffs really lead to economy in production. The scientific control of processes is the only certain way of reducing production costs to a minimum, and, incidentally, the data provided by scientific recording and control may well provide the background from which economic modifications of processes may emerge.

Again, in this highly technical and mechanical age, no industry can remain in the competitive market

which does not constantly review the efficiency of its plant and the efficacy of its processes. Modernization can only be achieved by constant research into such matters as the processes of combustion, the mechanism of heat transfer, the behaviour of metals under conditions of high temperatures, the causes of corrosion and abrasion of materials, and mechanical operating efficiency.

Finally, it is not enough merely to conduct research. It is essential that the means should exist whereby the conversion of the results of research into production should proceed as smoothly and efficiently as possible. In this respect consideration must be given to inter-departmental relations, and care must be exercised to ensure that the boundaries of research and production are not so narrowly defined as to include no common territory.

(2) "Every industrial unit should include a qualified official or officials with the specific duty of following general scientific technical developments and literature and of bringing to the immediate notice of the executive authority all matters related to the processes or products of the concern."

It is an unfortunate fact that in many industrial concerns the executive authority has no link with the scientific world, and has no means of assessing the relevance of the happenings in that world to its processes and products. The contributions to fundamental scientific knowledge by workers in Great Britain have been outstanding; the application of advances in scientific knowledge to the needs and requirements of industry have all too frequently been made elsewhere. The protection of these applications by patents has placed British industry at a serious disadvantage. The main reason for this state of affairs has been the lack of liaison between industrial managements, which shape industrial policy, and scientific establishments. Certainly a much more effective liaison exists in some other countries.

There is, then, an urgent requirement for practical interpretation of the trends of science to industrial executives, and this requirement cannot be adequately met by anything less than the inclusion in an industrial unit of a qualified official specifically charged with the duty of correlating the findings of scientific research with the firm's interests. Moreover, the emergence of new industries, or the considerable extension of old industries, following new advances in scientific knowledge, is dependent upon an individual or individuals grasping the possibilities of application, and by the belief in these possibilities being backed by those in executive authority. Obviously the existence in industrial units of officials charged with keeping an ever-watchful eye on the possibility of potential applications would facilitate the reaping of the practical harvests of science and would markedly shorten the inordinately long time-lag between discovery and application which has existed in the past.

In this connexion it is relevant to direct attention to the beneficial results which have followed the inclusion in executive authorities of qualified technicians and men of science. Such a member of the executive might well be the co-ordinating official referred to above; but in any event the technicalities of this age and the impact of science on industrial processes would seem to render the inclusion of science and technology among the managerial assets not only reasonable but also essential.

(3) "This conference holds that the application and use of science in daily industrial life in this country will require the progressive growth of industrial research facilities for both established and new industries. It urges every industrial concern to join and make the fullest use of its appropriate Research Association and, where practicable, to establish its own research department."

The problem of wedding science and industry in Great Britain is rendered the more difficult by the fact that, in the main, the average industrial unit is a small one, with severely limited financial resources. The establishment of a comprehensive research department, costing, say, £50,000, with an annual maintenance expenditure of £20,000, is quite beyond the capabilities of the great majority of industrial firms. The research association movement has had its critics; but a review of the past twenty-five years and consideration of the present situation compels the opinion that few wiser governmental decisions were ever made than that which led to the formation of research associations. The research association must provide for the average firm the facilities for the prosecution of basic applied research without which no sure foundations can exist on which to make particular industrial applications of scientific knowledge. But the existence of a research association does not exonerate any firm from establishing some research facilities or from creating in some part of its works a research atmosphere. At the least this may mean that one young scientific worker will be employed by any industrial unit, who will keep in close contact with the research association and who will assist in the translation of the results of the association's work into workshop practice. The firm will be more fortunate which can afford to establish even the smallest of research departments, which, apart from its intrinsic value to the firm, will serve as a constant reminder that, in these days, industrial processes are not static.

The general acceptance, even of necessity, of co-operation in research as exemplified in the research association may have one important advantage. Great Britain has been sadly handicapped by the difficulty experienced by one industry of obtaining materials peculiar to its own needs from another industry in the manufacturing field of which the materials lie. The co-operative research ideal should include a system of inter-industrial co-operative research, planned on a wide scale and making use of Government, university, research association, and industrial research facilities, with the object of removing all industrial handicaps resulting from the use of materials which only approximate in their properties to those which are ideal. Scientific men forgather for purposes of discussion and interchange of information at the meetings of learned and technical societies, and the largely increased employment of men of science in industry visualized by the conference, might well result in the creation of an atmosphere of inter-industrial sympathy and knowledge which would react most favourably on this wider co-operative effort.

(4) "This conference places it on record that an essential factor in pursuing these aims is the provision of increased facilities in educational establishments for training scientific and technical personnel and urges industrialists to stimulate such provision in their own field of interest."

The main obstacle to the achievement of a full measure of research activity in industry is not to be found in any hostility to the scientific worker or in any sense of complacency in industry, but in the scientific man-power situation. A healthy industry requires that far more scientific workers should be trained in the future than in the past. The larger universities are already as large as is consistent with efficiency, and it follows therefore that increased facilities must be created by enlargement of the smaller provincial universities and by the establishment of technical educational institutions in industrial areas where no university or technical college exists.

The Government is alive to the situation and has established the machinery for reviewing and, it is to be hoped, remedying the existing state of affairs. The problem of providing adequate facilities for technical and scientific training includes the provision of sufficient and qualified teachers. Since, under the best conditions, the teaching staff of a technical institution should be in close contact with technicians and scientific men engaged in industry, it is highly desirable that the remuneration of the teachers should compare favourably with that received by their industrial colleagues; and, in fact, suitable teachers will not be forthcoming unless such is the case. The last clause of the resolution is important, for past experience has shown that when industry has interested itself in local educational matters and has supported the local education authority, the battle for the provision of technical educational facilities peculiar to local requirements has been more than half won. Whatever Government scheme for technical education is forthcoming, its application to particular areas will undoubtedly be influenced by a display of stimulating interest on the part of local industry.

THE ROYAL ACADEMY, 1946

By Dr. A. T. HOPWOOD
British Museum (Natural History)

"CRITICS have always been people less susceptible than other men to the contagion of art. For the most part they are able writers, educated and clever, but with their capacity for being infected by art quite perverted or atrophied." Tolstoy's diatribe against critics was inevitably brought to mind by the present Summer Exhibition at the Royal Academy. The first impression was disappointing, and the critic had to determine where the fault might lie. Subsequent impressions were no more favourable; it proved distressingly easy to spot artist after artist without recourse to the catalogue. Another source of disquiet was the obvious dependence of many exhibitors on French artists of a generation or so ago. Neither of these is a healthy sign: the first indicates a tendency to fixity of style, to painting to a formula, and the second a lack of originality. It seemed likely, therefore, that there might be something wrong with the exhibits after all.

Now Tolstoy propounded a muddled variant of the generally held view that the fruits of an artist's labours constitute a work of art only in so far as they convey his emotions to the spectator; he also held the opinion, more popular than ever in certain circles to-day, that "art should belong to the people". Hence his high opinion of the untutored peasant as a judge of art. If such indeed were the case, the artistic value of "Flower Piece" by E. Wadsworth (No. 665), or of "Objects in a Scene of Devastation" by H. A. Lunn (No. 657) could not be rated very highly, for, whatever may have been the emotions of the artists as they painted, they are completely hidden from the vulgar perception. On the other hand, "Girl in Grey" by J. B. Souter (No. 454) would obviously be of higher artistic value, because a picture of a pretty girl standing with one hand resting on the mantelshelf seems to tell its own story. The falsity of this reasoning is not immediately apparent. That Mr. Souter's painting is of considerable artistic merit arises, not from the subject, but from the artist's skill in drawing and design, and from his sense of colour, and that this is the real explanation is shown by his other picture, "Wood Wind" (No. 520), in which there is no pretty girl to disturb the judgment.

But there is another and more puritanical, more 'scientific' theory of art. More puritanical because the emotions are heavily discounted, more 'scientific' because there is an elaborate classification of the different types of artists ranging from the 'original architectural artist' down to the 'venal popular artist'. R. H. Wilenski, the author of this theory, holds that a work becomes a work of art when it has been honestly and competently passed by its author as having satisfied his aims. From this fact alone it possesses an intrinsic value according to the artist's position in the classified scheme. There is also an independent and acquired value which arises from the reaction of the spectator. It then becomes the critic's function to endeavour to explain the artist's aim, and not to describe his own emotions.

Clearly, the intrinsic value is something peculiar to the picture and personal to the artist, and the spectator must assume that each of the exhibits has been honestly approved by the artist as having the primary intrinsic value; but the critic's task is not made any easier thereby for he has to attempt to explain something which is personal to another. More especially is this true of the present show, which is stolen by a picture painted more than seventy years ago. "Hearts are Trumps" by Sir John Millais is an example of a mastery which to-day is practically extinct. To dismiss this picture as 'popular romantic art' is entirely beside the point; it displays a knowledge and craftsmanship which are absent from the majority of the modern works, and those who affect to despise craftsmanship should remember Renoir's advice, "Be a good craftsman first of all; that won't prevent you having genius".

Good craftsmanship I take to include good drawing and good design, as well as good painting, but all three are rarely to be found on one and the same canvas. The weakest spots are usually drawing and design. One example of good craftsmanship is "Shipyard at Palma in Majorca" by C. Muncaster (No. 467), another is "Life Study" by Erica Suttill (No. 482). On the other hand, there are many works which by reason of their heavy impasto cannot be regarded as good painting. This is not to say that the artist has not achieved what he set out to do, nor that the result is bad, but merely that heavy impasto affords lodgment for dirt and dust, and that one regrets a pleasant sketch such as "Chilham Mill" by James Doxford (No. 8) should carry within itself the seeds of its own decay.

As usual, there is a large number of flower pieces of varying merit, and nearly as many still lifes, 'still life with trimmings' as it were, but only one

artist is at all original in his approach to the subject. For this reason "Flints and Fungus" (No. 180) and "Apple Log" (No. 221) are worthy of examination. Both are by Dudley Holland and neither is particularly well hung.

"Concarneau Harbour" by Murray Urquhart (No. 283) is painted in an impressionist manner, and with an impressionist palette. It illustrates once again how well suited this method is for outdoor subjects. A more modern way of dealing with buildings and trees is seen in "Houses by the New River" by Greta Ward (No. 88) and "West Hill, Highgate Village" by Peter Lowry (No. 864). In these there is little of the traditional recession of the planes; instead the artists give us a statement of the relationship of the various objects to each other when projected into one plane, the plane of the canvas or paper. Another picture of some interest is "Chelsea Terrace: Evening" by Robin Clifford (No. 176) which is in complete contrast to the two just mentioned. Where they tend to romance this tends to the factual, where they are relatively gay in colour this is drab, but the idiom is modernistic and not very comfortable.

One of the chief charms of water-colour drawings is that they possess a freshness and sparkle unobtainable in any other medium. Whether applied as washes or as blobs, water-colours are pre-eminent for rapid sketches; but they demand a skill and knowledge which will enable the artist to lay on the correct colour by first intention in the proper place, and afterwards to leave it alone. Any other way is apt to destroy the transparency of the medium and to lead to a muddiness which seems to be creeping back into modern practice. This is coming about through a revival of the old custom of applying an overall wash of yellow to the paper before starting work. Certain subjects benefit from this method, but as a general rule it leads to an undesirable lowering of tone. A more modern technique is to make slight sketches in pen or pencil and to do no more than indicate the artist's awareness of colour by means of occasional plain washes. To this class belong "Back Gardens" by Julia Morley (No. 748), and "Fête" by C. Bendall (No. 787) who has succeeded in conveying the movement of the dancing crowd in a convincing way.

The drawings and etchings in Gallery IX are pleasantly mixed. They range from the lively naturalism of Winifred Austen's "Marsh Tit" (No. 1054) through C. F. Tunnicliffe's "Wood Owl" (No. 1077) to "Nether Warden" by Clifford Webb (No. 1073) and "Rock Pool" by A. S. H. Mills (No. 1079). A drawing of "Professor J. T. Randall" by H. A. Freeth (No. 1008) is among the best of the portraits.

Architecture is not prominent this year: the number of exhibits is small compared with what one might have expected at a time when reconstruction is so much to the fore, but this is possibly a reflexion of the prevailing uncertainties of the situation. The majority of the plans are for public buildings. Plans for dwelling-houses are rare, but there are several blocks of flats, and housing schemes for local authorities.

Some of the animal studies in the sculpture gallery are good. I particularly liked "Gnu" by H. W. Palliser (No. 1172), "Ocelot" by Pamela Ascherson (No. 1255) and "Sleeping Cat" by W. G. Simmonds (No. 1262). Young artiodactyls seem to have an attraction for sculptors at the present time. This year we have "Lambs" by Rosamund Fletcher (No. 1202), "Fawn" by Faust Lang (No. 1205) and "Water Hole" by Alfred Oakley (No. 1208). The animal in the last-named piece has a tail which closely resembles that of a horse, and in this feature bears no resemblance to the young of any known ruminant.

Taken as a whole, this year's exhibition is disappointing. One has the feeling that artists, like other people, are tired and in need of inspiration rather than already in possession of it, or, at least, that they have not yet adjusted themselves to the conditions which are the legacy of war. To this many of them would possibly retort with Renoir's saying, "I have no theories; I paint for the sake of painting". They are the ones who, I suggest, will most rapidly find themselves again.

NEW FOREIGN MEMBERS OF THE ROYAL SOCIETY

As announced briefly in *Nature* of May 18, p. 651, the following have been elected foreign members of the Royal Society:

Dr. Herbert S. Gasser

Dr. Herbert S. Gasser, director of the Rockefeller Institute of New York, gave a new impetus to the physiology of the nervous system by his development of the technique of valve amplification and of recording with the cathode ray oscillograph, and by the exact analysis of the nerve action potential which he carried out with Prof. J. Erlanger. Making full use of the extended range of measurement, Gasser and Erlanger were able to show the composite nature of the action potential of a mixed nerve trunk and to measure the rates of conduction and the form of the electric response in the different types of nerve fibre. This work, for which they were awarded the Nobel Prize for Medicine in 1944, has led to a greatly increased understanding both of the biophysics of nerve and of the function of the different types of nerve fibre. It is now the basis of the exact studies of conduction within the central nervous system which are throwing fresh light on reflex activity.

Dr. Gasser is so well known to physiologists in Great Britain that his great personal influence and his successful direction of a famous institute need no comment. But his work for the joint war effort will be remembered, and in particular his many kindnesses to British men of science visiting the United States during the war period.

Prof. Frédéric Joliot

The election of Prof. F. Joliot to the foreign membership of the Royal Society, at the exceptionally early age of forty-five, is a sign of the great admiration and regard in which he is held by his British colleagues. Prof. Joliot occupies a place in the contemporary world which has no exact parallel; there must be few who can combine eminence as a scientific worker, administrator and man-of-affairs in such a high degree. As an experimental physicist he has shown the most fertile imagination and skill. Together with his wife, Irene Curie, he discovered

artificial radioactivity. When Rutherford congratulated them on this achievement, he said that he had himself sought for this phenomenon for thirty years. He had not succeeded in finding it, and this made him all the more appreciative of their success. Joliot's contributions towards the discovery of the neutron, of the properties of the positron, and of the phenomenon of materialization are notable. His experimental proof that more than one neutron is emitted in the fission of the uranium atom was a major step towards the invention of the atomic bomb.

Joliot had accomplished all this before the outbreak of war in 1939. During the occupation of France he became the head of the Front National, the resistance movement with more than one million members. At the same time, he directed brilliant researches on the application of radioactive tracer elements to biological problems; in particular, to the chemistry of iodine in the thyroid gland. Then, after the liberation, he became director of the National Centre of Scientific Research, and planned the reform and stimulation of scientific research in the whole of France. He has retired from this position on his recent appointment as High Commissioner for Atomic Energy, with direct responsibility to the President of the Provisional Government. These achievements are sufficiently remarkable, but to them is added great personal charm, which arouses the affection as well as the regard of his colleagues and friends. Prof. Joliot is a splendid representative of his people, and of French civilization, and his friends everywhere rejoice in his achievements and honours.

Prof. Theodor von Kármán

THEODOR VON KÁRMÁN, professor of aeronautics and director of the Guggenheim Aeronautics Laboratory at the California Institute of Technology, Pasadena, is now the leading aeronautical scientist in the world. Born in Budapest in 1881, he left Hungary in 1906, and by 1913 was director of the Aeronautical Institute at Aachen. In 1930 he settled in the United States, becoming an American citizen in 1936. During the War he was chief scientific adviser to the U.S. Army Air Corps. Kármán's researches in the theory of elasticity and its application to structures, and particularly in the mathematical theory of hydrodynamics and aerodynamics, and its applications to aeronautics, ballistics and hydraulics, show both great depth and great breadth of interest. In the teaching of aerodynamics and the hydrodynamics of real fluids, his work forms a substantial fraction of almost every course. Many phenomena and formulæ, now well known, bear his name: for example, the Kármán vortex-street, his method of boundary-layer calculation, the logarithmic resistance and heat-transfer formulæ, the solution for supersonic flow past projectile-shaped bodies, and so on.

Kármán's interests and influence, both in mathematics and engineering, are wider than his own research work. He has developed and directed two outstanding research centres, both of which achieved world-wide fame. Many engineering projects have been carried out under his guidance, and he has been officially consulted on many engineering problems. By books, lectures and personal example he has achieved a great and continuing influence on the rationalization of engineering practice wherever and whenever it became possible; and he has laboured successfully to present to mathematicians in a suitable form the difficult problems arising in engineering science.

Dr. E. A. Stensiö

DR. ERIK ANDERSSON STENSIÖ, of Stockholm, is perhaps the greatest living authority on the anatomical structure of fossil fishes. He has brought to his studies an ingenuity of technique that has not only been helpful in other fields but has wrested even from unpromising material a wealth of information, so that we know more of the structure of some of these fishes from a remote past than of many living representatives. Stensiö's account of the Triassic fishes of Spitsbergen published in 1921 was a most important contribution, and notable not merely because of the relative inaccessibility of the material but also because of the thoroughness of his account, which was illustrated by no less than thirty-five plates and ninety text figures, and the valuable comparison between these ancient types and the modern Ganoids and Teleosts. Other outstanding contributions were his studies of the Ostracoderms of Spitsbergen from the Silurian and Devonian rocks, and the monograph of the Cephalaspids of Great Britain which was published by the trustees of the British Museum.

NEWS and VIEWS

Scientific Adviser to the Army Council: Brigadier O. H. Wansbrough-Jones

BRIGADIER O. H. WANSBROUGH-JONES, who has been appointed scientific adviser to the Army Council in succession to Sir Charles Ellis, was educated at Gresham's School, Holt, and became a scholar of Trinity Hall, Cambridge, in 1922. After taking his honours degree in chemistry, he commenced research work in the Department of Colloid Science in 1926 and has been connected with that Department ever since. In 1930 he was elected a fellow of his College. On obtaining his fellowship he spent some time with Haber in the Kaiser Wilhelm Institute in Berlin. On his return to Cambridge, his administrative abilities led him to the tutorship of Trinity Hall and a departmental demonstratorship in the Department of Colloid Science, posts which he held until the outbreak of war. In 1939 he joined the army and after a series of appointments terminated as Director of Special Weapons and Vehicles. The departure of Wansbrough-Jones is a serious blow to his College, in which he was rapidly establishing himself as one of the best tutors, in that he was able to preserve that balance between the sciences and the arts, between the affluent and the poor, between the specialist and those with broad interests, which is the foundation of a good democratic college. The recent rapid growth of the Civil Service spirit and its accompanying technique in the universities of Britain renders it almost essential for science departments to have somebody on their staff who can translate and render intelligible the ever-increasing flow of notes, memoranda, return forms and the like, which are showered upon them. This admirable function was carried out by Wansbrough-Jones for the Department

of Colloid Science with great zest and efficiency. His departure leaves a gap that will not easily be filled again.

Dr. C. L. Wilson

Dr. C. L. Wilson, who has just been appointed professor of chemistry at Notre Dame University, Indiana, is a graduate of the University of Leeds. After a short period of research in Leeds, he moved to University College, London, where he continued his research work, first as a senior student, and then, since 1932, as a member of the staff of the Department of Chemistry. Since the beginning of the War in 1939, he has been seconded for service in industry, first with the research staff of I.C.I. (Dyestuffs Division) at Blackley, and then with Messrs. Revertex, Ltd., in London. He has published in the *Journal of the Chemical Society* and elsewhere a large number of papers, mainly on prototropy, the deuteration of organic compounds, the spectroscopy of deuterated compounds, isotopic indicator experiments with radioactive halogen, and the mechanism of reduction by dissolving metals. He has contributed considerably to the development of catalytic contact methods of organic synthesis.

Radio Aids for Ships

An international meeting on radio aids to marine navigation arranged by the Marine Division of the Ministry of Transport began in London on May 7 and is continuing for about three weeks. More than a hundred delegates from seven Commonwealth and fifteen other countries are attending as representatives of the mercantile marine and associated interests all over the world. The object of the meeting, which was opened by the Right Hon. A. Barnes, Minister of Transport, is to inform other countries of what is being done in the United Kingdom in the application of radio and radar techniques to marine navigation, to seek information on similar work in progress in other countries, and to prepare a provisional case for international standardization of radio navigational systems with special reference to the problems of the allocation of frequencies.

The first few days of the meeting were occupied with a series of lectures and demonstrations by British experts on the special problems of marine navigation and on the manner in which the various radio devices developed during the War could be applied under conditions of peace. These devices included radio-direction finders for use on ship or shore, beacons of all types, and the systems which involve a measurement of the difference in time of travel of radio waves from two or more stations and which are now generally classified under the term 'hyperbolic navigation'. Later, the delegates had an opportunity of seeing most of the radio apparatus in operation in one of H.M. ships during a voyage down the Thames Estuary. Visits were also arranged to one of the transmitting stations of the Decca Navigator Company, to the National Physical Laboratory, and to the works of various manufacturers of electrical and other apparatus used in connexion with marine navigation. The Marconi group of companies also arranged an exhibition in London to coincide with the meeting, so that delegates and others interested might have an opportunity of seeing the various types of radio communication and navigation equipment now available, together with measuring apparatus and installations for diathermy and electro-surgical treatment.

New Optical Glass

Messrs. Chance Brothers, Ltd., Smethwick, have produced a new glass to be known as Type No. O.N.19. It is available in rolled sheets with semi-diffusing surfaces, and for optical purposes requires to be ground and polished. The rolled sheet is usually 5–6 mm. thick. It has a coefficient of expansion lower than ordinary glass and hence is less liable to fracture when subjected to stresses due to given thermal changes; coefficient of linear expansion per degree centigrade (0–100°) is 54×10^{-7}. It is claimed that it is more efficient as a transmitter of visible light and a heat absorber than any other glass previously made in Britain. It is at least equal to any previously available from foreign sources: for radiation from a source at 2,848° K. and a thickness of glass of 2 mm., the total light and heat transmissions are 88 and 14 per cent approximately; for glass 3 mm. thick the figures quoted are 87 and 8·5 per cent respectively.

Fourier Series

At the thirty-second session of the Indian Science Congress, held at Nagpur in 1945, Dr. B. N. Prasad, president of the Section of Mathematics and Statistics, delivered an address on the summability of a Fourier series and its conjugate series. Fourier series are of very great importance in both pure mathematics and mathematical physics. Fourier himself dealt with physical applications, ignoring theoretical difficulties, but these difficulties have proved of great interest. It has long been known that the Fourier series corresponding to a continuous function may fail to give the correct values of this function at an infinite set of points. To get over this difficulty, we may use a generalization of the process of finding the sum of an infinite series, such as that due to Cesàro. It may be recalled that Hardy and Rogosinski, in their Cambridge Tract on Fourier series, could not find space for theorems concerning Cesàro summation of general order. Thus Dr. Prasad's address, which is clearly written, is a useful supplement to the Tract. Dr. Prasad himself has made many contributions to the subject.

Physical Society: Officers for 1946–47

The following have been elected officers of the Physical Society: *President*, Prof. D. Brunt; *Vice-Presidents*, Sir Edward Appleton, Prof. N. F. Mott, Mr. A. J. Philpot, Prof. H. R. Robinson; *Hon. Secretaries*, Mr. J. H. Awbery, Dr. W. Jevons; *Hon. Foreign Secretary*, Prof. E. N. da C. Andrade; *Hon. Treasurer*, Dr. H. Shaw; *Hon. Librarian*, Prof. L. C. Martin; *Members of Council*, Prof. J. D. Bernal, Dr. B. Chalmers, Dr. C. H. Collie, Mr. E. R. Davies, Prof. G. I. Finch, Dr. W. B. Mann, Dr. A. C. G. Menzies, Prof. R. Peierls, Dr. D. Roaf, Dr. W. Stiles, Dr. F. C. Toy, Dr. W. D. Wright.

The officers of the three Groups for 1946–47 are as follows: *Colour Group: Chairman*, Dr. R. K. Schofield; *Hon. Secretary*, Dr. W. D. Wright. *Optical Group: Chairman*, Instr. Capt. T. Y. Baker; *Hon. Secretary*, Mr. E. W. H. Selwyn. *Low-Temperature Group: Chairman*, Sir Alfred Egerton; *Hon. Secretary*, Mr. J. H. Awbery.

Prof. Angelo Mosso (1846–1910)

The foremost Italian physiologist of his time and generation, Angelo Mosso, who was born in Chieri, Piedmont, on May 30 a hundred years ago, was a

student of Moritz Schiff of Florence, Carl Ludwig of Leipzig and Claude Bernard of Paris. In 1878 he was appointed to the chair of physiology at Turin (where he had graduated M.D. eight years previously), which he held until his death from diabetes at the comparatively early age of sixty-four. An indefatigable and original investigator and a popular teacher, his school became a physiological Mecca, where he trained men such as Aducco, Fano, Patrizi, Treves and Herlitzka. Master of a facile pen, among his best-known books are "La paûra" (1884), "La fatica" (1891), "La fisiologia dell'uomo sulle Alpi" (1897), and "Mens sana in corpore sano" (1903). Mosso's name is attached to the 'ergograph' which he invented in 1890 for recording voluntary contraction, and to the Istitute Angelo Mosso on the top of Monte Rosa, some 9,000 ft. above sea-level, the scene of some of his most original work. Here he studied the phenomena of respiration at altitudes above the snow-line. His acapnia theory (1897) that mountain-sickness is caused by the increased washing out of carbon dioxide from the blood in the lungs was later corrected by Haldane, Douglas and Barcroft. Mosso's contributions to physiology were characterized by versatility and exceptional technical skill. An apostle of physical exercise, he founded football clubs on English lines.

The Night Sky in June

FULL moon occurs on June 14d. 18h. 42m., U.T., and new moon on June 29d. 04h. 06m. The following conjunctions with the moon take place: June 2d. 00h., Venus 0·2° S.; June 2d. 18h., Saturn 3° S.; June 4d. 19h., Mars 3° S.; June 9d. 03h., Jupiter 4° S.; June 30d. 10h., Saturn 3° S.; June 30d. 23h., Mercury 3° S. In addition to these conjunctions with the moon, the following conjunctions occur: June 12d. 13h., Venus in conjunction with Saturn, Venus 1·7° N.; June 18d. 05h., Mars in conjunction with Regulus, Mars 0·8° N.; June 24d. 01h., Mercury in conjunction with Saturn, Mercury 1·5° N. Occultations of stars brighter than magnitude 6 are as follows, the latitude of Greenwich being assumed: June 13d. 00h. 48·5m., β Scor. (*D*); June 13d. 00h. 49·6m., 56B. Scor. (*D*); June 13d. 01h. 24·9m., β Scor. (*R*). Mercury sets about 1½ hours after the sun from the middle to the end of June and can be seen in the western sky after sunset. Venus is conspicuous in the western sky, setting at 22h. 28m. and 22h. 17m., at the beginning and end of the month respectively. The portion of the illuminated disk visible on the earth varies between 0·85 and 0·77 during June 1–30. Mars can be seen before midnight, setting at 0h. 19m., and 22h. 54m. at the beginning and end of the month respectively. The stellar magnitude of the planet varies from 1·5 and 1·7 between the above dates. Jupiter sets at 2h., and 0h. 06m. at the beginning and end of the month respectively and is stationary on June 15. The stellar magnitude of Jupiter is −1·8 throughout the month. Saturn sets nearly 3 hours after the sun on June 1, but after the middle of the month is too close to the sun for good observation. The fact that all five planets are visible at the same time towards the end of the month is worth noticing. An eclipse of the sun, invisible at Greenwich, occurs on June 29, and on June 14 a total eclipse of the moon, partly visible at Greenwich, takes place. The moon leaves the umbra at 20h. 33·6m. and the penumbra at 21h. 45·1m., and as moonrise at Greenwich occurs at 20h. 17m., very little of the eclipse is visible. Summer solstice is on June 21d. 01h.

Announcements

THE Albert Gold Medal of the Royal Society of Arts, which was struck in memory of the Prince Consort in 1864, has been conferred by the Society this year on Sir Alexander Fleming and Sir Howard Florey, as a joint award, for their services in the discovery and development of penicillin.

THE Gold Medal for 1946 of the Society of Antiquaries, given for distinguished services to archæology, has been awarded to Mr. Edward Thurlow Leeds, recently keeper of the Ashmolean Museum, Oxford, and known for his work on Anglo-Saxon art and archæology.

THE Haldane Prize of the Institute of Public Administration has been awarded to Dr. H. E. Martin, a principal medical officer of the Ministry of Pensions.

MR. E. B. WEDMORE, until recently director and secretary of the British Electrical and Allied Industries Research Association, has been elected president of the British Bee-Keepers' Association.

THE following have been elected officers of the Chemical Society for the ensuing year: *President*, Prof. C. N. Hinshelwood; *Treasurer*, Mr. F. P. Dunn; *Honorary Secretaries*, Prof. D. H. Hey, Dr. J. L. Simonsen, Prof. W. Wardlaw.

A JOINT meeting of the Chemical Society and the University of Oxford Alembic Club will be held in the Physical Chemistry Laboratory, University of Oxford, on June 6 at 2 p.m. to discuss "The Chemistry of Anti-Bacterial Substances". A luncheon to precede the meeting is being arranged; those wishing to attend should notify Mr. F. M. Brewer, Inorganic Chemistry Laboratory, South Parks Road, Oxford, not later than May 27.

THE Scottish Council for Health Education is holding three summer schools on the general theme "Healthy Living" this year. There are to be two elementary courses, at the University of St. Andrews during June 29–July 12 and the University of Edinburgh during July 13–27. The third course is intermediate and will be held at the University of St. Andrews during August 3–17. Further information can be obtained from the Secretary, Scottish Council for Health Education, 3 Castle Street, Edinburgh 2.

A COURSE on "Relaxation Methods" will be given in the City and Guilds College, Imperial College of Science and Technology, during July 9–August 1, 1946. A fee of £5 will be charged for the four weeks course (five days a week, including practical work). Applications should be sent to D. N. de G. Allen, Imperial College, London, S.W.7, from whom full particulars can be obtained.

THE following appointments have been made in the University of Sheffield: C. V. Jones, to be lecturer in electrical engineering; B. Donovan, to be assistant lecturer in physics; Dr. F. Segrove, to be assistant lecturer in biology; I. S. Maxwell, to be assistant lecturer in geography; B. R. Dudley, to be research assistant to the professor of engineering. Prof. G. A. Clark, professor of physiology, has resigned his chair to accept a post in the Ministry of Health; Lieut.-Colonel R. T. Percival, lecturer in metallurgy, and Mr. G. E. Walker, research assistant in glass technology, have also resigned.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Two Anomalies in the Ionosphere

DURING the War, many new ionospheric stations were instituted in different parts of the world to serve the operational requirements of the Allied Forces. As a result, there have become available, for the first time, sufficient data to provide a rough general morphological picture of the F_2 layer of the ionosphere. A study of these data has disclosed the remarkable result that, although ionospheric events in the E and F_1 layers are similarly reproduced at the same local time on the same day at all locations on a line of constant geographic latitude, the same is by no means the case for the F_2 layer. It has also been confirmed, as was suspected earlier, that under conditions of symmetrical solar illumination, an asymmetry of ionization exists for certain

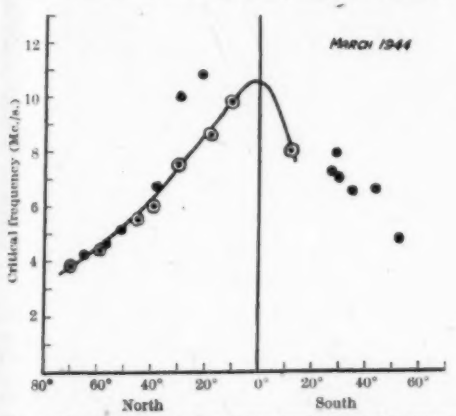

Fig. 1. VARIATION OF CRITICAL FREQUENCY WITH GEOGRAPHICAL LATITUDE

station on the same longitude and situated at equal latitudes north and south of the equator.

These phenomena are best illustrated by considering maximum noon ionization densities in the F_2 layer at the equinoxes, when the sun's zenith distance, χ, is the same for equal latitudes north and south of the equator. From a study of this kind for March 1937, it was found that the values of critical frequency f_{F_2} for Wuchang (lat. 30·5° N.) and Tokyo (lat. 35·6° N.) were definitely higher than those for Watheroo (lat. 30·3° S.) and Sydney (lat. 35·3° S.). An asymmetry of ionization for sites of equal latitudes north and south of the equator, and of roughly the same longitude, was suspected. Many other examples of the same phenomenon have been noted in more recent results.

In 1943, a further anomaly was identified when equinox noon values for two sites of approximately the same northern latitude, but widely different longitudes, were compared. It was found that the f_{F_2} values for Delhi (lat. 28·5° N., long. 77·1° E.) were substantially higher than those for Baton Rouge (lat. 30·0° N., long. 90·0° W.), indicating a variation of noon ionization with longitude along a line of constant latitude.

These two anomalies are illustrated in Fig. 1, where all the available March 1944 values of f_{F_2} at noon are plotted as a function of geographical latitude. The values corresponding to a narrow range of longitude (60°–90° W.) are ringed, and the curve drawn through them shows clearly the asymmetry about the geographical equator. The 'longitude effect' is illustrated by the fact that the values for Delhi (lat. 28·5° N.) and for Kihei (lat. 20·8° N.) lie completely off the curve. The longitudes of these two stations are, respectively, 77·1° E. and 156·5° W.

In Fig. 2 the same values are plotted as a function of magnetic dip, and it will be seen that the above-mentioned anomalies in respect of the low-latitude stations have substantially disappeared. A geomagnetic control of f_{F_2}, for low values of sun's zenith distance, is therefore indicated. It should, however, be noted that, for higher latitudes and thus for higher values of χ, the longitude effect is practically absent, since f_{F_2} is more closely related to geographical latitude than to magnetic dip.

Later results, with a greater wealth of data, have confirmed the general shape of the continuous line drawn in Fig. 2, though it is not yet certain whether or not the two maxima reach equal values. It appears that, for noon equinox conditions, there is a belt of low values of f_{F_2} circling the earth and centred roughly on the magnetic equator. For stations situated within this belt it is found that these low values are associated with marked bifurcation of the F layer into the F_1 and F_2 strata. Such bifurcation is accompanied by the usual phenomena (for example, low noon value, evening concentration of ionization, slow electron disappearance after sunset, etc.) with which we are familiar under English summer conditions[1]. In other words, the longitude effect and the geomagnetic control are exhibited not only in the noon values of f_{F_2} but also in the whole diurnal behaviour.

I am indebted to the collaborating ionospheric authorities in America, Australia, India and New Zealand for permission to use the results of their measurements in the above figures. This work was carried out as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research.

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[1] Appleton and Naismith, *Proc. Roy. Soc.*, A., **150**, 685 (1935).

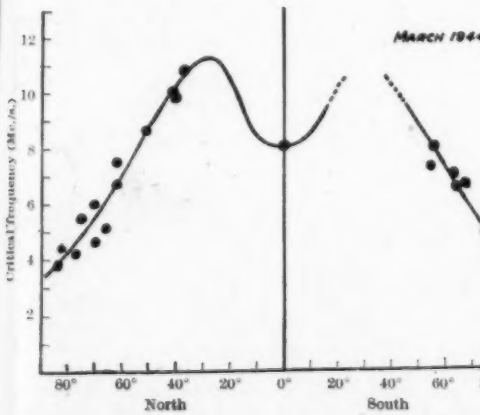
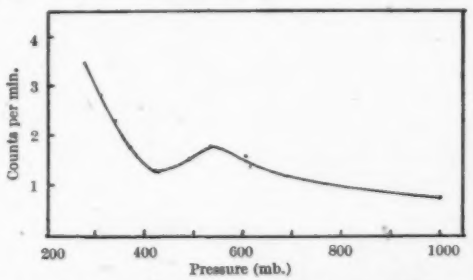


Fig. 2. VARIATION OF CRITICAL FREQUENCY WITH MAGNETIC DIP

Mesotron Intensity as a Function of Altitude

DURING July 1945, measurements of the intensity of mesotrons passing through 8 cm. of lead at various heights in the Himalayas up to an altitude of 16,800 ft. were made by me and Mela Ram[1]. During November 1945, I extended these measurements up to 33,000 ft. above sea-level in an aeroplane flight over Lahore. The apparatus used in the flight was the same as that used in the hills. The duration of the flight between 17,000 ft. and 33,000 ft. was one hour and forty minutes. The results are shown in the figure in the form of a curve in which the number of triple coincidences per minute are plotted against the pressure in millibars.



The intensity versus pressure curve for mesotrons is generally given as an exponential. The data as given here are certainly not represented by a simple exponential. In the neighbourhood of 550 millibars, there occurs a sudden break in the curve which suggests that the data can best be represented either by two exponential curves or by a continuous curve giving a hump at this pressure. Two more flights were made, extending the measurements to 35,000 ft. The data collected in these flights also indicate a similar shift in the mesotron intensity versus pressure curve at about the same altitude. This would mean that the effect is a real one. I will deal with this point in greater detail after the projected flights throughout India during April beginning from the magnetic equator to about 24° N. magnetic latitude are completed.

I am deeply indebted to Air Commodore A. H. Wheeler of the R.A.F. for putting at my disposal a 'Mosquito' in which the flights at Lahore were carried out. My thanks are also due to Wing Commander E. S. Fallick, Squadron Leader R. H. Allen, Flight Officer I. D. Gregory and other officers and men of the R.A.F. for their uniform courtesy and co-operation in these flights.

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The Auroral Spectrum

THE exact mode of excitation of the lines and bands in the auroral spectrum is not yet fully understood. Many attempts have been made to explain the spectrum, but none has been convincing[1,2,3]. The purpose of the present note is to offer a simple explanation of the auroral spectrum on the lines of the theory of emission of similar lines and bands from the luminescent layer of the night sky postulated by me some time ago[4,5]. Besides similarities, there are also differences between the two spectra; but these are to be traced mostly to the difference in the atmospheric heights at which the two phenomena originate: the height of the most frequent occurrence of aurora is between 90 and 120 km. (regions *D* and *E* of the ionosphere), and the height of the luminescent layer of the night sky is 200–400 km. (region *F* of the ionosphere). The collisional frequency of the atmospheric particles, which affects the emission of the spectra, is about two orders higher in the lower than in the higher region.

The primary cause of excitation of the auroral spectrum is bombardment by charged particles shot off from the sun. The spectrum consists of band systems of molecular nitrogen and certain lines of atomic oxygen. These are, in order of prominence: first negative bands, N_2^+ ($A' \rightarrow X'$); auroral green line λ 5577 O ($^1S \rightarrow {}^1D$); first positive bands, N_2 ($B \rightarrow A$); red auroral triplet, λ 6300 O ($^1D \rightarrow {}^3P$); second positive bands faintly, N_2 ($C \rightarrow B$) and Vegard–Kaplan bands very faintly, N_2 ($A \rightarrow X$). In regard to the atomic oxygen lines, it is to be noted that calculations show that oxygen gas in the upper atmosphere is photo-dissociated by absorption of solar ultra-violet radiation (Runge–Schumann continuum[6]). Above 115 km. the gas is almost completely dissociated; the dissociation extends down to 100 km. where it is estimated to be 7 per cent. Bombardment by charged particles shot off from the sun might also dissociate oxygen molecules and push the dissociation down to lower levels.

The bombardment, however, cannot be the immediate cause of excitation of all the spectra. As is well known, the red and green auroral lines are not ordinarily excited in a discharge tube or when oxygen gas is bombarded by canal rays, though other lines of O are excited. The reason for the difference between upper atmospheric spectra and the discharge tube spectra is the part which the walls of the tube play in promoting quick disappearance of the products of ionization, for example, electrons, ions and metastable particles. The electrons and ions recombine mostly on the surface (rather than in the volume), which acts as the third body absorbing the excess of energy and momentum. The metastable particles also, as they find their way to the walls, deliver up their energy by collision to the glass surface rather than by radiation. In the upper atmosphere, since there is no glass wall, the products of bombardment persist; and by reacting among themselves or with the neutral particles, they excite spectra not ordinarily obtained in discharge tubes. (In connexion with the above, I have recently put forward the hypothesis that active nitrogen is only N_2^+ ions produced by the discharge[7]. They persist in the after-glow vessel due to special conditioning of the walls, which prevents the neutralization of the electrons and ions on the surface. The conditioning is probably caused by adsorption of nitrogen, which has very little electron affinity.)

It is necessary, therefore, to distinguish between that part of the auroral spectrum which is directly excited as a result of bombardment and that which is excited as a result of the interaction of the products of the bombardment (ions and electrons) among themselves and/or with the neutral particles. To the first category belongs the first negative bands due to N_2^+ and to the second the rest of the spectrum.

First negative bands. The bombarding particles directly ionize and, at the same time, excite the N_2^+ ions produced to the A' state from which the first negative bands are emitted. That the bombardment of the upper atmosphere produces ionization is shown by ionospheric observations in high latitudes[8]. During auroral displays the ionization increases in intensity and extends down to the radio-wave absorbing region (*D*), which causes obliteration of radio echoes. Assuming an isothermal atmosphere and that the light intensity is proportional to the ionization, Vegard has calculated the intensity distribution with height due to the bombarding action of fast charged particles entering the atmosphere[9]. The calculated distribution curve is very similar to the observed distribution curve for a large class of auroras. The first negative bands are also easily produced in the laboratory by the bombardment of nitrogen gas by cathode rays[10].

First positive bands and the oxygen lines. The mode of excitation of these is the same as that which I have proposed in the night sky. Briefly, it is as follows: the oxygen atoms, on account of their high electron affinity, attach to themselves electrons and form negative ions. These react with N_2^+ ions as follows: $N_2^+ + O^- \rightarrow N_2$ (excited) + O (excited). From the excited nitrogen molecules and oxygen atoms, the first positive bands and the green and red radiations are emitted respectively. (For further details original papers should be consulted.)

Second positive bands. The above reaction cannot account for these bands on account of inadequate energy. That their mode of excitation must be different is also evident from the fact that the nitrogen molecules after emission are left in the vibration levels 0–4 of the *B*-state. The observed first positive bands, however, originate from levels 8–11 of the same state. The faint emission of the second positive bands may be explained as due to the recombination of N_2^+ ions and electrons by a radiative process:

$$N_2^+ + e \rightarrow N_2(B) + h\nu.$$

The cross-section of N_2 for this reaction is, however, small, being only 10^{-22} cm.^{2} as compared with 10^{-6} cm.^{2} for the other process.

The enhancement of the first positive bands in the rare case of the so-called red auroras of type *B* (arcs and draperies, of which the lower fringe reaching abnormally low heights of 65–70 km. is tinged red) falls in the first category. The bombarding particles are slowed down by deep penetration and excite the nitrogen molecules by direct impact.

Effects of higher collisional frequency on the auroral spectrum. Faintness of $V-K$ bands; greater strength of the green O-line than the integrated strength of the red lines; 'height effect', namely, comparative strengthening of the red O-radiations on passing up an auroral streamer.

These effects distinguish the auroral spectrum from the night sky spectrum. They are easily explained if the long lives of the metal stable states from which they originate and the decrease of collisional-frequency with height are taken into account. In regions of high collisional frequency, the molecules or atoms in metastable states have a greater chance of coming down to a lower state by collision with other atmospheric particles than by radiation.

Sunlit aurora. The remarkable enhancements of the negative bands of N_2^+ and of the red oxygen lines in sunlit aurora have been the subject of much comment, but no explanation has yet been given. The explanation is, however, simple if similar enhancements in the case of the night sky spectrum taken during twilight—when the rays of the rising or the setting sun touch the high atmosphere—are considered. (Compare, for example, the spectrum of the former taken by Störmer[11] and that of the latter by Elvey[12].) The enhancement of the negative bands is due to production of N_2^+ ions in the A'-state by absorption of $\lambda < 661$[13]. The enhancement of the red-lines (as compared with the green line which is unaffected) is due to two factors acting in the same sense. First, the absorption coefficient of the oxygen atom for $\lambda < 6392$ for excitation to the ^1D-state is much higher than that for $\lambda < 2972$ for excitation to the ^1S-state; and secondly, the density of solar radiation in the first spectral region is about a hundred times greater than that in the second. (The case of enhancement in night sky spectra during twilight is fully discussed by Ghosh[5].)

The subject-matter of the communication is being studied in fuller detail by Mr. S. N. Ghosh, my research scholar, and will shortly be published in the *Proceedings of the National Institute of Sciences of India*.

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Feb. 13.

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Electronic Spectra of some Bent Triatomic Molecules

THE purpose of this communication is to summarize the results obtained by us during recent years on the absorption electronic spectra of the SO_2, SeO_2 and TeO_2 molecules. Whereas the size and the fundamental frequencies of SO_2 are known accurately[1], no corresponding data exist for SeO_2 and TeO_2. It has, however, been established that the selenium dioxide molecule has a similar bent structure[2] and, by analogy, we may infer that this is also the case for tellurium dioxide.

The electronic spectra of these three molecules were studied repeatedly[3], but a detailed analysis was given only for the *b* and *c* systems of SO_2[4] and for the *b* system of SeO_2[5]. Here, we are dealing with the *a* system of SO_2, the *c* system of SeO_2 and with a preliminary investigation of the TeO_2 bands.

SO_2.—The *a* system of SO_2 was observed in absorption between 2000 and 2400 A. under widely varied experimental conditions of temperature and pressure (200°–700° K.; 0·5 mm.–100 mm. mercury pressure) and with an absorption path from 5 cm. to 100 cm. The dispersion used was either 2 A./min. or 5 A./min. at 2200 A. Contrary to the statements of Price and Simpson[4], we have shown that the prominent bands constitute several different progressions. They can be fitted into two separate electronic systems designated a_1 and a_2, with the following molecular constants of the upper state:

a_1 ... $\nu_1' = 962$ cm.$^{-1}$, $\nu_2' = 379$ cm.$^{-1}$, $x'\nu_2' = 2$ cm.$^{-1}$, $\nu_0 = 42{,}170$ cm.$^{-1}$
a_2 ... $\nu_1' = 775$ cm.$^{-1}$, $\nu_2' = 375$ cm.$^{-1}$, $\nu_0 = 44{,}236$ cm.$^{-1}$

The bands of the a_1 system appear to be of the perpendicular type with *K* structure well defined and degraded towards the red. The analysis gives $C' = 0{\cdot}9$ cm.$^{-1}$ as compared with $C'' = 1{\cdot}6$ cm.$^{-1}$. The *J* structure is not resolved, but there are indications that the corresponding sub-bands are slightly degraded towards the red and that the convergence is slow. If so, we have a case already discussed by Metropolis[4] and related to $\Delta\alpha < 0$ and $\Delta r \cong 0$, with $B' \cong B''$. From Fig. 2 of the paper referred to we can conclude that α has decreased by about 20°, while r_0 has increased a little.

There are only two allowed transitions giving perpendicular bands. One of them ($4\ a_1 \rightarrow 2\ b_2$) has been assigned by Mulliken[7] to the *c* system ($\lambda_{max.} = 3700$ A.). Thus the a_2 system must correspond to $1\ a_2 \rightarrow 4\ b_2$ transition. We must point out that this attribution does not agree quantitatively with Mulliken's scheme of SO_2 levels. But according to Mulliken himself, the scheme has not much more than a qualitative meaning.

We have not succeeded in analysing the fine structure of the a_2 system. Perhaps it could be correlated with $3\ b_2 \rightarrow 5\ a_1$, as proposed by Mulliken, for the whole *a* system. But this new interpretation would even modify the order of the electronic terms in Mulliken's scheme

In any event, the large difference between the valence frequencies of the excited states shows that one of them is relatively much more anti-bonding than the other.

The detailed discussion of the very important scheme of levels given by Mulliken must be postponed until new experimental data in the 2000 A. region are available. We are now engaged in such experiments.

SeO_3.—The *C* system extending between 5000 and 3400 A. has been photographed at temperatures ranging from 300° to 500° C., the pressure varying from 50 mm. to 450 mm. mercury, with absorbing layers of 2–400 cm. Our measurements are generally in accordance with those of Evans[4] and Choong Shin-Piaw[5], who give no interpretation of their results.

The most characteristic feature of the system is the presence of several ν_2' series with $\nu_2' \cong 200$ cm.$^{-1}$. For the normal state we obtain $\nu_2'' = 910$ cm.$^{-1}$, confirming our previous result based on the analysis of the *b* system[2]. The lack of bands that could be attributed to the excited valence frequency indicates that valence bonds are practically unchanged.

In the long wave-length region of the spectrum, the bands are degraded towards the red, and the reverse is observed on the ultra-violet side; whereas in the centre, the bands are diffuse. This fact seems to be due to an isotope effect.

In any event, the noticeable intensity of the system and the absence of antisymmetrical frequencies show that it results from an allowed transition. It may correspond with the *C* system of SO_3 ($A\,a_1 \rightarrow 2\,b_1$).

Metropolis[6] noted that the ratio I_c/I_b is practically constant (1·17) for a series of angular molecules such as SO_2, NO_2, ClO_2. If we extend the validity of this rule to SeO_2, it provides an apex angle of about 130°. Furthermore, we have noted that the ratio of the antisymmetrical and symmetrical frequencies of the same molecules is also constant with the value 1·17 (the identity of the constants seems to be fortuitous).

On the basis of this relation, we obtain for SeO_2 the value $\nu_3'' = 1050$ cm.$^{-1}$. On the other hand, the general character of the spectrum indicates that ν_2'' must be about 400 cm.$^{-1}$.

With the three fundamental frequencies obtained, and by using a valence-deformation force field, we compute an apex angle of about 160°. In order to obtain a more plausible angle of 130°, it is sufficient to include in the potential function small negative cross-terms of about $0{\cdot}5 \times 10^5$ dyne/cm. Hence we seem to have a new case of an angular molecule where the presence of cross-terms is beyond any doubt[6].

TeO_2.—The TeO_2 as well as the SeO_2 bands were previously analysed by Choong Shin Piaw[5], who divided the spectrum into several electronic systems. As important objections can be made to his vibrational analysis, chiefly in regard to the non-observance of the selection rules, we have undertaken a new investigation of the main *b* system situated between 3000 and 4500 A. with a maximum absorption at 3600 A.

Our measurements are in satisfactory agreement with those of Choong, but we have been able to correlate all the bands of the system with only one valence symmetrical frequency in each state: $\nu_1'' = 815$ cm.$^{-1}$; $\nu_1' = 650$ cm.$^{-1}$.

According to this result, the system may be considered as analogous to the *b* system of SeO_2. In addition to the main bands, some fainter bands situated on the short wave-length side of the spectrum can be arranged in several series with $\nu \cong 200$ cm.$^{-1}$. It can be identified with a deformation frequency in the upper level, but we cannot yet decide whether it belongs to the same electronic transition.

It is perhaps worth while to note the close agreement between the fundamental valence frequency of these three molecules (1154, 910, 815 cm.$^{-1}$) and the fundamental frequency of the corresponding diatomic molecule (1123, 908, 796 cm.$^{-1}$).

Details of our investigation will be published elsewhere in the near future.

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March 20.

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The Normal and Power Vortex in Meteorology

NUMEROUS attempts[1] have been made to apply the simple plane vortex of hydrodynamical theory to the structure of symmetrical pressure centres on the synoptic weather chart. These studies, which are based on the so-called simple vortex, in which the tangential velocity at a distance r from the centre is given by

$$vr = \text{a constant},$$

are inadequate, since the simple vortex encounters convergence difficulties both at $r = 0$ and as $r \rightarrow \infty$. Such a system of winds would have an infinite kinetic energy associated with it, while a consistent pressure field would have an infinite potential energy.

A study has been made of plane vortex systems which are free from these embarrassing disadvantages, in particular the 'normal' vortex, in which the pressure field is given by

$$p = \text{const.} + h \exp - r^2/a^2,$$

and the power vortex, the field for which is

$$p = \text{const.} + h/(1 + r^2/a^2)^{\frac{1}{2}\mu}.$$

The normal vortex is completely defined by two parameters, the strength, h, and the spread or dispersion, a. The power vortex distribution resembles the normal distribution in general profile but the pressure decreases more slowly with r in the outer part of the vortex. It requires for its complete specification the index μ in addition to the two parameters already mentioned.

In applying such vortices to the large pressure systems of the synoptic weather chart, it is assumed that the variation of surface density and of the earth's vertical component of rotation does not vary within the vortex. The retarding influence of surface friction on wind speed is also ignored.

For the cyclone or anti-cyclone of temperate latitudes, it is assumed that winds are nearly geostrophic. With this assumption it can be shown that

$$V_m R/h = \text{a constant},$$

where V_m is the maximum wind speed at distance R from the centre. This constant is equal to $4{\cdot}8 \times 10^6$ gm.$^{-1}$ cm.^{3} sec. in the case of a normal distribution, and to $2{\cdot}9 \times 10^4$ in the case of the power vortex, index zero. The mean value for this parameter determined from data for seventeen cyclones published by Goldie[2] is $2{\cdot}5 \times 10^6$.

The power vortex gives rather a better fit than the normal vortex, wind speeds in which fall off too rapidly with distance from the centre.

It can be shown that the potential energy associated with a normal vortex is

$$\pi a^2 h Z C_p / 2(C_p - C_v),$$

where C_p and C_v are the specific heats of air at constant pressure and constant volume, respectively, and Z is the vertical extent of the pressure disturbance. The corresponding total kinetic energy of the vortex is

$$\pi Z h^2 / 18 \rho_s \omega^2,$$

where ω^2 is the vertical component of the earth's rotation, and ρ_s the density of surface air. Analogous expressions hold in the case of the power vortex.

A cyclone of fixed strength loses kinetic energy as it moves to higher latitudes. This may be compensated by a decreasing spread leading to a diminution in the (negative) potential energy of the vortex. The precise interchange of energy in the atmosphere can only be found by investigation: the important point is that the normal vortex, or the power vortex, provides models of the cyclone or anti-cyclone, by means of which one is able to discuss the large-scale energy balance in the atmosphere.

In temperate regions the wind is approximately geostrophic, but in the tropics the geostrophic control is weaker, and in the inner parts of the tropical cyclone, at least, the cyclostrophic force is the main one balancing the pressure gradient.

A vortex in which the cyclostrophic control is predominant is rather different from that we have already discussed. The constant of such a system is

$$V_m^2/h.$$

This constant in the case of a normal vortex is 600 gm.$^{-1}$ cm.^{3}, or for a power vortex, index 1, 420 gm.$^{-1}$ cm.^{3}. The mean value of V_m^2/h for eighteen tropical cyclones is 490 gm.$^{-1}$ cm.^{3}, with extreme values of 190 and 910. If allowance is made for the effects of surface friction, the value of this ratio will be increased to more than 700.

The normal vortex would seem to fit the data better than the power vortex for small r, but for moderate values of r, V falls off too rapidly with increasing r.

The study of normal and power vortices has so far been confined to large-scale atmospheric systems; but there is the likelihood of applications being found to vortices of the scale encountered in connexion with turbulence phenomena, and, indeed, in all hydrodynamical studies in which the overall energy of individual vortices must be known.

A more complete account will be published elsewhere.

I am indebted to the Director of the Meteorological Office for permission to communicate the above.

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March 14.

[1] Goldie, A. H. R., "Kinematical Features of Depressions", M.O. Geophys. Mem. No. 72 (1937), gives full references to the literature.
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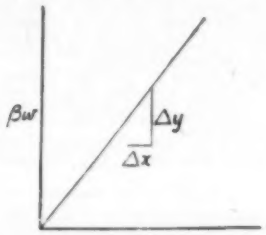
Linear 'Curves of Best Fit'

THE text-book treatment of linear curves of best fit purports to give the best estimate of the relation $w_1 = \rho v_1$ between variables of true value w_1, v_1, from a set of measured values, w, v. It is applicable when only one parameter is subject to errors of measurement. Thus, when only the values of w are subject to error, the best estimate is given by the curve which minimizes the sum of squares of deviation of w, that is, the regression line of w on v; and for errors in v only, the regression line of v on w should be taken.

We have had occasion to ask the question, What is the best estimate of ρ when both w and v are subject to normal errors? The following rather intuitive solution has been verified rigorously for the special case of a sample containing a normal distribution of true values. It is of wide application and certain of its implications are of some interest.

The standard deviations σ_w, σ_v of the measured values are assumed to be constant throughout the range, and w, v are taken relative to

the respective mean values as zero. If the pairs of measured values are plotted on new scales: $y = \beta w$, $x = v$, where $\beta = \sigma_v/\sigma_w$, deviations in x and y are of equal weight.



Let Δx, Δy represent deviations of a measured point from a point on a line representing the true relation. Now, by the principle of least squares, the best estimate of the true relation is obtained by minimizing the sum of values of $(\Delta x^2 + \Delta y^2)$, that is, by the principal axis of smaller second moment.

When transformed back to the original scales, this curve is the line through the origin and of slope

$$\rho = \frac{\left\{\left(\frac{1}{k\beta} - k\beta\right)^2 + 4r^2\right\}^{1/2} - \left(\frac{1}{k\beta} - k\beta\right)}{2r\beta} \quad . \quad (1)$$

where $\beta = \frac{\sigma_v}{\sigma_w}$, $k = \sqrt{\frac{\Sigma w^2}{\Sigma v^2}}$, $r = \frac{\Sigma wv}{\sqrt{\Sigma w^2 \Sigma v^2}}$

It may be noted that when variables are subject to error, the equations of the regression lines will vary systematically with the range and distribution of true values, whereas that of the curve of best fit given by (1) will not. The appropriate regression line, however, for example, of w on v, gives the most probable measured value of w corresponding to a measured value v, provided this value has been drawn from a population with a distribution of true values similar to that of the sample. If there is no information as to range, or the range is different and, in particular, if it is desired to extrapolate, then the curve of best fit is to be preferred.

When, as sometimes occurs, the relative uncertainty of the two sets of measurements is not known, but there is reason to ascribe some error to each set of values, it is convenient to make the assumption $\sigma_w = \rho\sigma_v$, for the expression for the slope then becomes:

$$\rho = \sqrt{\frac{\Sigma w^2}{\Sigma v^2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which does not involve Σwv, which need not therefore be calculated.

Since making this analysis we have noticed that a similar problem has been considered by Seares[1]. His solution, in our nomenclature, is

$$\rho = \left(\frac{\overline{w^2} - \sigma_w^2}{\overline{v^2} - \sigma_v^2}\right)^{1/2} \quad . \quad . \quad . \quad . \quad (3)$$

tends to our expression (1) as the size of sample increases. We believe, however, that our treatment gives the better estimate when the difference is appreciable, as may happen with small samples.

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[1] Seares, F. H., *Astrophys. J.*, **100**, 255 (1944).

Flow of Gases through Fine Powders and the Measurement of Specific Surface

Rigden[1] has given a modified form of Kozeny's equation, corrected for the 'slip' which becomes appreciable when the voids of the powder are not incomparably greater in width than the molecular mean free path of the gas. If the voids are much narrower than the mean free path, however, so that intermolecular collisions are very rare, the flow ceases to be governed by the viscosity of the gas and becomes a process of diffusion.

It can be shown that the diffusion coefficient is given by Meyer's uncorrected formula for self-diffusion, that is:

$$D = \frac{\lambda\bar{c}}{3},$$

where λ, the mean free path, is determined by the dimensions of the voids. By geometry the free path is found to be:

$$\lambda = \frac{4\varepsilon}{S(1-\varepsilon)\rho}$$

using Rigden's notation.

It follows from these relations that the mass-flow per unit area per unit time is given by:

$$Q = -\frac{8}{3}\sqrt{\frac{2M}{\pi RT}} \cdot \frac{\varepsilon^2}{S(1-\varepsilon)\rho} \cdot \frac{dp}{dx}$$

where x is measured in the direction of flow.

This equation enables the specific surface of a powder of any degree of fineness to be calculated from permeability measurements made at a suitable gas pressure. It has the advantage of involving no empirical constants. The accuracy of the method is being investigated here.

W. R. Holmes

B. Laporte, Ltd.,
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March 18.

[1] Rigden, P. J. *Nature*, **157**, 268 (1946).

I am interested to note that an attempt is being made to use a 'molecular flow' formula for the air permeability method instead of a corrected Poiseuille formula. I have been aware of this possibility and have derived an equation, based on the law of molecular flow through a tube at very low pressure, with a porosity function of the same form as that given by Holmes, namely,

$$\frac{\varepsilon^2\Delta p}{(1-\varepsilon)\rho S l}.$$

This method has not been examined experimentally here, as the powders we are normally concerned with are not fine enough.

This formula is only valid if the diameter of all pores in the bed of powder is considerably less than the mean free path, a condition which will only obtain if a sufficiently fine powder is used or if the working pressure is sufficiently low. I would suggest that, at atmospheric pressure, only powder as fine as carbon blacks would meet this requirement (say, 50 m.²/gm.).

Any formula, whatever its theoretical basis, for relating specific surface of a powder to its permeability when compacted into a bed, must contain an empirical constant which has to be determined experimentally. It will be interesting to see whether surface areas deduced by Holmes' formula agree with those found by other methods, for example, the nitrogen adsorption method.

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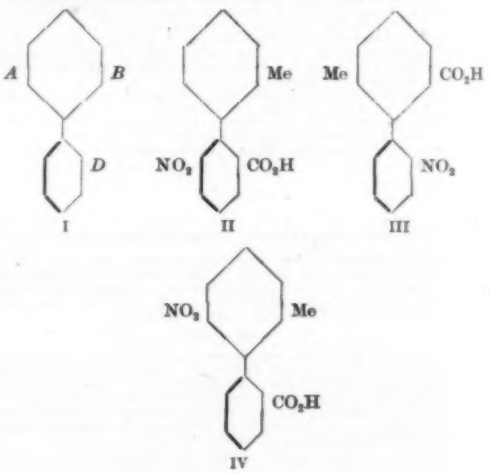
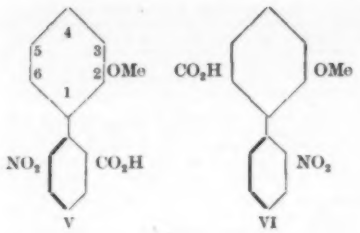
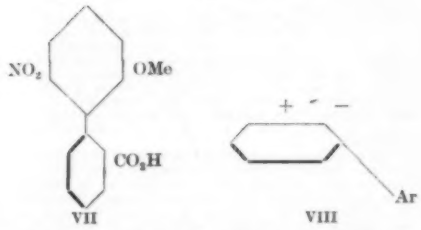
Optical Stability of Diphenyl Derivatives

On the assumption that the racemization of a 2 : 2′ : 6-trisubstituted diphenyl (I) involves the rotation of the two benzene rings relative to one another about the bond joining them as axis, the rate of racemization must depend on the ease with which the substituents *A* and *B* or *B* and *D* (depending on whether *A* or *B* is the smaller) can pass one another.

Adams and Hale[1] have made a study of the isomerides II, III and IV and have found that their rates of racemization decrease in this order. These authors point out that since the relative sizes of the substituents are $NO_2 > Me > CO_2H$, the racemization of II and IV should involve the methyl group passing the carboxyl group, and that of III, the nitro group passing the carboxyl group; consequently, the rates of racemization should be II = IV > III. Similarly[2], the rates of racemization of V, VI and VII decrease in this order, whereas the relative sizes of substituents, $NO_2 > CO_2H > OMe$, would be compatible with rates V = VII > VI.



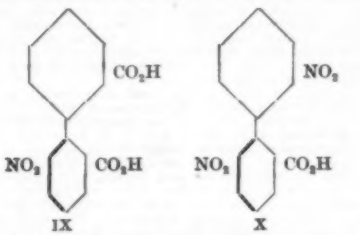




Apparently, the sizes of the substituents are not the sole determining factor of the rates of racemization.

Fischer models of these diphenyl derivatives show that the rotation required for racemization encounters much less obstruction when the bond joining the two rings is displaced from the plane of one of them by the introduction of a tetrahedral carbon atom. The displacement is shown in VIII, and its occurrence must depend on the ability of the carbon atom at which it occurs to acquire a negative charge, for the configuration is that of a negatively charged carbon atom. If such a displacement plays a part in facilitating racemization, this displacement will occur in the ring of greater electron density, and the rate of racemization will be related to the electron density in this ring.

Data from various sources have shown that the nitro group exceeds the carboxyl group in decreasing the electron density of an aromatic ring to which these groups are attached, whereas the methyl and methoxyl groups have the opposite effect. On the assumption that the effect of the carboxyl group lowers the electron density to a greater extent than does the combined effect of the nitro and methyl groups or the nitro and methoxyl groups, each of the diphenyls II–VII has been written with the ring of greater electron density uppermost. Comparing these upper aromatic rings with one another, the electron densities are in the order II > III > IV and V > VI > VII, which is also the order of the rates of racemization. This connexion between electron density and rate of racemization is strengthened by the influence of various substituents on the optical stability of V[1]. In general, the more 'negative' the substituent in the *upper* ring, that is, the lower the electron density in this ring, the greater the optical stability. Thus, the 4-nitro derivative is more stable and the 4-methyl derivative less stable than V. These substituents have a smaller effect on the stability when attached at the 5-position; here, they have a smaller effect on the electron density at the 1-position.



Finally, the racemization of IX and X should be related to the electron densities in the upper aromatic rings, since these contain only one 'negative' substituent: comparing these upper rings, only that in IX undergoes a considerable increase of electron density when the acids are converted into the corresponding anions by the addition of alkali. The accompanying table shows that the addition of alkali greatly decreases the optical stability of IX but not that of X.

Solvent	Half-life period (min.) IX	X
CH_3CO_2H	91·9	125·1
n—C_4H_9OH	101·1	91·9
NaOH(0·1 *N*)	4·6	91

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[1] Adams and Hale, *J. Amer. Chem. Soc.*, **61**, 2825 (1939).
[2] Adams and Finger, *J. Amer. Chem. Soc.*, **61**, 2828 (1939).
[3] Handford and Adams, *J. Amer. Chem. Soc.*, **57**, 1592 (1935).

Cyclo-octatetraene

RECENT work by Reppe[1] has proved that Willstätter's hydrocarbon C_8H_8 has indeed the cyclo-octatetraene structure which was originally assigned to it. Its reactions enabled him to conclude that "the double bonds of cyclo-octatetraene are open to all the reactions of ethylenic chemistry". This conclusion might at first sight be taken to indicate the absence of resonance in this molecule. However, this would be in contradiction to the physical data on the heat of combustion and the absorption of light, which can be taken as indicative of a resonating molecule. The heat of combustion leads to a value of 28 kcal. for the resonance energy, compared with 41 kcal. for benzene. The substance is described as a golden yellow liquid, which places the long wave-length ultra-violet system corresponding to the 2600 A. band of benzene at about 4000 A. If it contained fixed double bonds, then the absorption would be expected to lie below 2000 A. Thus the evidence from the heat of combustion and the absorption spectrum indicates a resonating molecule.

Penney[2] and Wheland[3] have studied the quantum mechanics of a planar, non-strained ring of eight CH-groups by the valence bond method. The predicted ratio of the resonance energy of this model to the resonance energy of benzene is 1·17. Accepting this model, it would not appear unreasonable to attribute the difference between the calculated and observed resonance energies, that is, (1·17 × 41–28) kcal. or 20 kcal. to strain. Forster[4] has shown that resonance between the two Kekulé forms should lead to a maximum of absorption at 4100 A., in good agreement with experiment. As neglect of the excited structures of the canonical set leads to a very poor approximation to the resonance energy, it was thought desirable to carry out a calculation of the light absorption using the complete set of fourteen structures. A preliminary treatment neglecting the second excited structures leads to a value of 3550 A. for the maximum of the long wave-length ultra-violet system. The inclusion of the four second excited structures does not alter this value appreciably. The fact that the calculated absorption maximum lies at a shorter wave-length than the observed would be consistent with a strained molecule.

If the resonance energy and the light absorption of a strained molecule are known, then it is possible to estimate the strain in both the ground and excited states. If, as might be expected, the strain is reduced in the excited state, then the molecule should absorb at a longer wave-length than that calculated with the neglect of strain. Another interpretation of the low value of the resonance energy is that the ring is puckered. The strain in the ring would thus be reduced at the expense of the resonance energy. At this stage it would be difficult to decide between the two possibilities.

It now remains to reconcile the chemical behaviour of the molecule with its resonance. In the first place, its resonance energy is of the order of that calculated by Kovner[5] for octatetraene (24 kcal.). Hence it would be expected to behave rather as a conjugated system than as an aromatic one. Again, the reactivity of cyclo-octatetraene may be due to the formation of a stable transition state[6]. It is of interest to note in this connexion that cyclo-octatetraene, like open-chain polyenes, is capable of reacting with benzoquinone and maleic anhydride, its reactions in these cases being typical diene syntheses. The question of the reactivity of cyclo-octatetraene would need further investigation, but it would appear that the chemical evidence is not necessarily in conflict with the physical and theoretical.

It is hoped to publish these results in more detail later, when the resonance energies and light absorption of a number of non-benzenoid aromatic hydrocarbons have been investigated.

I wish to express my gratitude to Dr. A. Wassermann for discussion on this topic.

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April 13.

[1] Report on Cyclopolyolefins, W. Reppe (Chem. Soc. Library, 1944).
[2] *Proc. Roy. Soc.*, A, **146**, 223 (1934).
[3] *J. Chem. Phys.*, **3**, 230 (1935).
[4] *Z. Elect.*, **45**, 548 (1939).
[5] *Acta Physicochimica U.R.S.S.*, **19**, 385 (1944). See also Pauling and Sherman, *J. Chem. Phys.*, **1**, 679 (1933), in which the value 30 kcal. is obtained.
[6] Evans, *Trans. Faraday Soc.*, **35**, 824 (1939).

Secondary Electron Photography

IN a letter in *Nature* (**156**, 150; 1945), Messrs. Tasker and Towers describe a method for the radiography of thin objects such as paper and fabrics, using secondary electrons emitted from a sheet of lead irradiated by high-voltage X-rays. Reference is made to complications which sometimes arise owing to the emission of electrons from the material radiographed, in the worst cases a partially positive picture appearing.

During the course of an examination of this method of radiography, a striking demonstration of the emission of photo-electrons from heavy elements has been observed. Some of the test objects used were postage stamps kindly loaned by Mr. W. H. S. Cheavin. Radiography by means of 10 kV. grenz rays showed that many such stamps were printed with inks containing a metallic base, and give a remarkably well-defined radiographic negative.

When these stamps were examined by the method of Tasker and Towers, a rather poor positive image was obtained. This suggested a further step, namely, the removal of the emitting lead sheet, and the direct radiography of the specimen with high-voltage radiation. The result was a positive image produced by the secondary electrons from the ink, and equal in quality to the grenz-ray radiograph. We therefore have the somewhat surprising result of two 'radiographs' of the same object, taken under almost identical conditions, the picture with 10 kV. radiation being negative, and with 190 kV. positive. A typical example of this phenomenon is shown in the accompanying photographs. To avoid confusion, both radiographs were taken

directly on photographic printing paper, hence the mirror image reversal. It may be noted that in the electron photograph, only the printing ink produces an image, there being no indication of the surrounding paper.

(*a*) (*b*)

(*a*) Radiograph with 10 kV. X-rays; (*b*) 'radiograph' with 190 kV. X-rays.

It seems possible, using the original method of Tasker and Towers, to make at least a rough estimate of the range of the secondary electrons emitted from metals. By placing a step wedge of 'Cellophane' between a sheet of lead and a photographic plate and irradiating with 170 kV. X-rays, it appears that the electrons are stopped by a thickness of 'Cellophane' equivalent to approximately 0·012 gm./cm.².

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Nickel and Multiple Trace Element Deficiencies in Agricultural Crops

IN the course of work promoted by the Agricultural Research Council on mineral deficiency, wheat and other crops on Romney Marshes responded in 1944 to diagnostic injections[1] of compounds of manganese, iron, boron, copper, zinc and nickel. Field experiments on a factorial pattern were carried out in 1945 to test the significance of these diagnoses. All the crops (wheat, potatoes and broad beans) that were sprayed with solutions containing these elements gave increases in yield for each of the six elements. All these increases in yield were statistically significant and economically important; except that for copper and zinc on wheat the odds were only 14 : 1 and 11 : 1 respectively that the effect was not due to chance. A non-factorial experiment on cabbages gave corresponding results but at a low level of significance.

We believe this to be the first indication that nickel is of importance in increasing crop yield, and also the first record of zinc deficiency in the British Isles that has been proved by the increase in yield as a result of treatment with zinc. Thompson and Roberts[2], however, have recorded an improvement in the foliage of cherries as a result of zinc injection.

The importance of the zinc deficiency was established in experiments carried out in a field of potatoes selected because of the wide-spread and severe symptoms characteristic of manganese deficiency[3]. Although there was a striking improvement in colour and appearance of foliage as a result of spraying with manganese alone, there was no detectable yield effect. Spraying with zinc sulphate alone, however, raised the yield from 27 cwt. per acre (odds 30 : 1), while the effect of spraying with both zinc and manganese was to raise the yield 78 (to a total of 227) cwt. per acre with odds of more than 1,000 : 1 that the effect was not due to chance.

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Detection of Manganese Deficiency in Plants by Tissue Tests, Using Tetramethyldiaminodiphenylmethane

THE tissue test method[1-3] has proved useful in the diagnosis of mineral element deficiencies in a variety of crop plants. Using this technique, however, it has not been possible hitherto to detect deficiency-levels of manganese in plant extracts, due to the fact that Morgan's reagent (100 gm. sodium acetate and 30 ml. glacial acetic acid per 1 litre at pH 4·8) does not extract sufficient manganese from healthy or manganese-deficient tissues to be detected by the formaldoxime test[2]. The minimum concentration for which this reagent can be used is 1 part in 5 million. The value of the latter reagent in detecting excessive concentrations of manganese in plant tissue extracts has been reported previously[2,3,4].

Recently, a more sensitive reagent, tetramethyldiaminodiphenylmethane[5,6] has been used successfully by me to detect traces of manganese in plant tissue extracts. Special measures were taken to purify all reagents, to ensure that glassware was scrupulously clean and that the plant material used was free from dust. The plants used in the initial tests were healthy and manganese-deficient oats; the latter had been grown in fen soil and exhibited typical visual signs[2] of manganese deficiency. The results for healthy and manganese-deficient oats were more than 100 and 20 parts of manganese per 1,000 million respectively.

The procedure finally adopted for testing healthy and manganese-deficient cereal tissues is as follows. 1 gm. of macerated stalk tissue is extracted for 15 min. with 10 ml. of purified Morgan's reagent and 5 ml. of the extract pipetted off into a clean specimen tube. 0·5 ml. of a saturated aqueous solution of potassium periodate is then added, followed by 0·1 ml. of a 1 per cent solution of tetramethyldiaminodiphenylmethane in acetone. The intensity of the resultant blue colour is proportional to the manganese present in the extract. Prepared manganese standards made up in Morgan's reagent are used for matching purposes.

The following special precautions are taken prior to testing. Water, glacial acetic acid and acetone are redistilled, and sodium acetate, potassium periodate and tetramethyldiaminodiphenylmethane are recrystallized. Glassware and plates used are washed with hydrochloric acid, and thoroughly rinsed with glass-distilled water, alcohol and acetone and then dried. The plant material is brushed with a soft camel-hair brush to ensure that dust particles do not adhere to the outer surfaces. The stainless steel scalpel used to cut up the tissues must be sharp, and it is rinsed with redistilled acetone and dried before use.

Using this procedure, a number of test cases of manganese deficiency in cereals from field crops have been confirmed, but the applicability of the test to other crop plants for the detection of deficiency-levels remains to be established. The sensitivity range, from 100 to 1 part per 1,000 million, should, however, be adequate for most crops.

In the original publications[2-4], chloroform is recommended as a solvent for the reagent, but more consistent results have been obtained with acetone.

This work has been carried out with the aid of a special grant from the Agricultural Research Council and will be reported fully at a later date.

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Blood Groups in Tribes of Tierra del Fuego and their Bearing on Ethnic and Genetic Relationships

BLOOD groups were determined years ago by Rahm in two tribes of Tierra del Fuego. In *Onas*, prevalence of group *O* was found, as in American Indians in general; but out of 33 *Ydmanas* (*Yâgans*) only three were stated to belong to group *O*, and thirty to group *B*[1]. On account of this extraordinary finding, we decided to examine blood groups in these two tribes and in that of the *Alakalufs* living in the zone of the Tierra del Fuegan channels and never before studied as to their blood groups. This work was urgent as these three tribes are on the way to extinction.

Determination of blood groups was made partly by A. S., and partly by A. L. and L. R., in 40 *Ydmanas* at different places on the northern and southern shores of the Beagle Channel, especially on the Chilean island of Navarino, and in 20 *Onas* and 17 *Alakalufs* met in Río Grande (Atlantic border of Isla Grande de Tierra del Fuego), Punta Arenas (Magallanes) and other places. When making contact with the *Ydmanas* we soon became convinced that a study of blood groups in the tribes of this country will be of use only when a most careful inquiry has been made independently into the ethnic and genetic conditions of every individual. This work was done by G. M. To appreciate rightly the situation, it must be borne in mind that even in primitive tribes, as in our own society, ἔθνος by no means coincides with γένος. We have found in the three tribes cases of 'ethnic mutation', for example, two '*ydmanas*' born of an *Alakaluf* mother and a Chilean father! We counted these individuals as *Alakalufs*. As to ethnic mutation from Indian to white, this also is a question of choice, though greatly dependent upon economic or social standards, as has been discussed more fully elsewhere[2]. Several 'whites' of *Ona* or *Ydmana* extraction living in the tribe or in close contact with it were added to the respective tribe in our summary.

The findings of Rahm as to the prevalence of group *O* in the *Onas* were corroborated by our work. But we were unable to confirm his findings in the *Ydmanas*; in our material, 31 out of 40 *Ydmanas* were of group *O*. It was the same with the *Alakalufs*, where 13 out of 17 were of group *O*. Of the 77 individuals belonging ethnically or genetically to the three tribes mentioned, 58 individuals, that is, 75 per cent, were group *O*; the remaining 19 individuals were of group *A* (11), *B* (7) and *AB* (1).

The significance of these 25 per cent of non-*O* groups in the tribes of Tierra del Fuego was obtained when our material was sorted into two categories: that of 'Indians', that is, individuals of 'pure' race or belonging to crosses between members of the three tribes; and that

of 'mestizos', that is, belonging to crosses with whites. (The total number of individuals *known* to be of *Ona*, *Yámana* and *Alakaluf* extraction, that is, 'Indians' *and* 'mestizos', as classified above, is, according to our information received from different sources, about 40 *Ona*, 60 *Yámanas* and 80–100 *Alakalufs*. The last figures are the least accurate because the *Alakalufs* wander in their canoes about the channels.) There were in the category of 'Indians' 5 *Onas*, 20 *Yámanas* and 9 *Alakalufs* or crosses between these: *all the 34 individuals were without any exception of group O*. On the other hand, in the category of 'mestizos' there were 43 individuals, of which only 24 were group *O*, and *all* the 19 mentioned belonging to *A*, *B* and *AB*. This sorting was possible thanks to the help of the Indians themselves, who have a fairly high level of education, and of the civil and medical authorities. So we were able to trace in most of these 19 cases the white source of the respective blood factor.

It is evident from our findings that the authentic Indians of the Tierra del Fuegan tribes of *Onas*, *Yámanas* and *Alakalufs* are all of group *O*, and that the presence of individuals of groups *A*, *B* and *AB* in these tribes is due to miscegenation with whites of Chilean, Argentine, Spanish or British extraction.

Cordial thanks from the whole team are due to our geographical adviser, General Ramón Cañas-Montalva, and to the Chilean Air Force for unique facilities afforded; to the naval authorities of Ushuaia on the Argentine shore of Isla Grande; to the local farmers who lodged and fed us; and to many others, and last but not least, to our Indian friends.

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Determination of Dienoestrol in Biological Samples

THE widespread clinical and veterinary use of the synthetic œstrogens has made it desirable to be able to assay these substances in biological samples, but until now no practical chemical method has been reported, although Dingemanse[1] and Malpress[2] have published methods applicable to non-biological samples.

A method for the determination of dienœstrol in biological material has been developed here, depending on the fact that dienœstrol combines with maleic anhydride to form a bicarbonate-soluble adduct.

Method. After acidifying, the sample is continuously extracted for 24 hours with benzene, the benzene extract concentrated and exhaustively extracted with aqueous sodium bicarbonate or carbonate. The aqueous layers are discarded. Excess maleic anhydride is then added, and after standing, the excess removed by water extraction. The dienœstrol maleic anhydride adduct is recovered by extraction with aqueous sodium bicarbonate, acidification of the latter, followed by ether extraction. Removal of the ether gives the free dicarboxylic acid of the adduct which may be weighed and then titrated against standard alkali, thus giving a value for the original amount of dienœstrol present.

In urine, recoveries of 60–80 per cent of added dienœstrol are obtained down to 1–2 mgm. per litre. Below these concentrations results tend to be high, due to the fact that there is a small blank reading with most urines so far tested.

It is probable that the method can be rendered more sensitive by applying a colour reaction to the adduct.

Further work is proceeding on the method, and detailed results will be published elsewhere.

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Folic Acid in the Nutrition of Certain Insects

WE have recently shown[1] that the caterpillars of the flour moth, *Ephestia kuehniella*, grow slowly on a purified diet in which all the known vitamins of the B-complex are provided in pure substance. The length of the larval stage is about 7–8 weeks, as compared with 5–6 weeks on a diet which contains yeast or yeast extract. A preparation of dried grass juice (Cerophyl Laboratories) was found to be an excellent source of the missing factor which, in its relations to charcoal, seemed to behave like folic acid[2]. It was adsorbed on norrite at *p*H 3 and was contained in the eluate, but not in the filtrate. We later obtained synthetic folic acid (Lederle Laboratories)[3] and established that this is the missing factor. On a purified diet, with folic acid, most of the larvæ pupated after 5–6 weeks; whereas without folic acid they mostly died and none pupated before the eighth week. The minimal optimal requirements seem to be about 2 μgm./gm. of the dry diet, that is, of the order of the riboflavin requirements of another insect, *Tribolium confusum*. We have also some evidence that crystalline vitamin B_c (Parke Davis and Co.)[4] has a similar, if not identical, effect as folic acid.

Folic acid is also of great importance in the nutrition of the mealworm, *Tenebrio molitor*. On a purified diet, which in addition to the known B vitamins also contains a liver charcoal filtrate, which by the nature of its treatment would be expected to contain little or no folic acid[5], growth is slow, and the mortality increased, while addition of synthetic folic acid has about the same effect as 1 per cent yeast, as seen in the accompanying table:

		After 9 weeks	
		Number surviving out of 40 larvæ	Average weight (mgm.)
1.	Purified diet plus 1 per cent yeast	37	43
2.	Purified diet plus liver charcoal filtrate	30	8·7
3.	Purified diet plus liver charcoal filtrate plus folic acid (10 μgm./gm.)	40	38

These findings seemed to contrast with our earlier work with the flour beetle, *Tribolium confusum*, for which a mixture of the known vitamins of the B-complex in pure substances supported growth as well as yeast or an aqueous yeast extract[6]. On certain occasions recently it has been impossible for us to repeat this result, and all the evidence points to the fact that recent samples of casein, which had been highly purified for the purpose of assaying vitamins, were lacking in something which was contained in earlier samples. It is now clear that this deficiency is caused by a lack of folic acid. In an experiment, using 'Labco' casein, with folic acid added, the larval stage of the first eleven larvæ to pupate (out of twenty) lasted between 30 and 32 days, whereas without folic acid it lasted between 42 and 47 days.

Folic acid has also recently been reported to be of importance in the nutrition of mosquito larvæ, where it is necessary for pupation[7]. The authors of this investigation used, however, a concentrate of folic acid and not the pure substance.

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Gladiolic Acid: an Antifungal and Antibacterial Metabolic Product of *Penicillium gladioli* McCull and Thom

IT has been shown by Wilkins and Harris[1,2] that *Penicillium gladioli* produces an antibacterial substance when grown on liquid nutrient media. We have found that culture filtrates produced by this mould are toxic to fungi, the antifungal effect being more marked than the antibacterial effect. We have now succeeded in isolating the active substance in pure form from culture filtrates, yields as high as 300 mgm. per litre having been obtained, and have studied its biological and chemical properties.

The active material may be obtained by growing *P. gladioli* on shallow layers of Raulin–Thom medium (7·5 per cent dextrose) until an activity of 32 B.A. units per ml., as determined by the *Botrytis allii* spore germination assay[3], is reached. After removal of the mycelium, the culture filtrate is adjusted to *p*H 4·0 with hydrochloric acid and treated with activated charcoal (B.D.H.) at a rate of 5 gm. per litre. The charcoal is filtered off, dried at room temperature and extracted with ether. On evaporation of the ether, a brown or yellow pasty material is obtained.

This was purified by several recrystallizations from water and dried *in vacuo* over sulphuric acid. It crystallizes in long, colourless, silky needles, m.p. 160° C., containing no halogens, sulphur or nitrogen. It is optically inactive. Microanalyses (Weiler and Strauss): Found: C = 59·7, 59·75 per cent; H = 4·56, 4·74 per cent; —OCH_3 = 12·0, 11·3 per cent; mol. wt. (Rast.) = 212. $C_{11}H_{12}O_5$ requires: C = 59·4 per cent; H = 4·54 per cent; —OCH_3 = 14·0 per cent (for one —OCH_3); mol. wt. = 222·1. The compound is a monobasic acid (equivalent found by titration = 228, 207), and we propose to call it 'gladiolic acid'. A number of well-defined crystalline derivatives have been obtained, and its chemical properties are consistent with those that might be expected for a methoxy methyl-2-carboxyphenyl glyoxal.

Gladiolic acid gives an interesting colour reaction with strong ammonia solution. Initially a very deep green colour is produced but, after about 12 hours, this changes to red and finally, after several days, to orange.

Gladiolic acid shows some antibacterial activity. In nutrient broth at *p*H 7 it prevents growth of *Staphylococcus aureus* at 250 μgm./ml., but fails to prevent growth of *Salmonella typhi* or *Escherichia coli* at 500 μgm./ml. It is much more markedly fungistatic. As is usual with organic acids showing fungistatic activity, the activity is related to hydrogen ion concentration. At *p*H 3·5, where there is a higher proportion of undissociated molecules, there is a marked fungistatic effect, a concentration of 2 μgm./ml. preventing germination of *Botrytis allii* conidia; at *p*H 7, where the acid is largely dissociated, a concentration of 100 μgm./ml. is needed to prevent germination of *B. allii* conidia. Aqueous solutions of gladiolic acid in dilute buffer (McIlvaine's) retained their activity when stored for 10 days at 25° C. in a range of *p*H 3–8.

Full accounts of the chemistry of gladiolic acid, of its production and its biological properties will be given elsewhere.

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Cytological Localization of Riboflavin (Vitamin B_2) and Thiamin (Vitamin B_1) by Fluorescence Microspectrography

FLUORESCENCE microspectrography has hitherto chiefly been utilized for the localization of porphyrins in thin sections of tissue, especially of pathological deposits of porphyrins in the tissues. The characteristic fluorescence spectra of the porphyrins and the comparatively great concentration of porphyrins have facilitated the use of the method under such conditions. On the other hand, difficulties have been encountered in identifying other fluorescent substances in histological sections by fluorescence microspectrography.

An ultra-violet fluorescence microspectrographic method has been elaborated which allows of an accurate analysis of the distribution of the relative energy in fluorescence spectra obtained from details

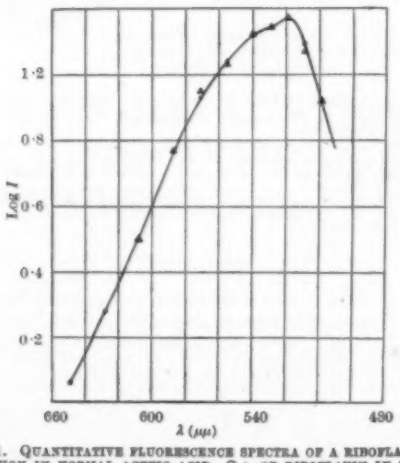

Fig. 1. QUANTITATIVE FLUORESCENCE SPECTRA OF A RIBOFLAVIN SOLUTION IN NORMAL ACETIC ACID, ⊙; OF RIBOFLAVIN IN THE CHORIOIDEA OF THE FROG'S EYE UPON MICRO-EXTRACTION WITH NORMAL ACETIC ACID, △

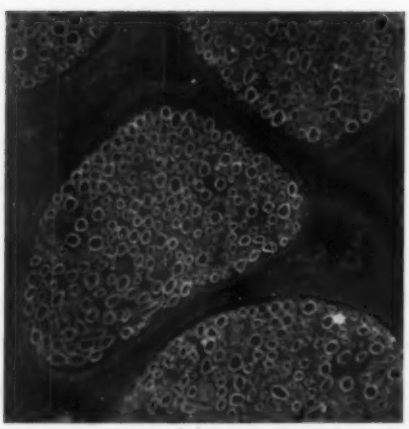

Fig. 2. ISCHIADIC NERVE IN RABBIT, FLUORESCENCE PHOTOMICROGRAPH. STRONG BLUISH-WHITE FLUORESCENCE FROM THE MYELIN SHEATHS. × 500

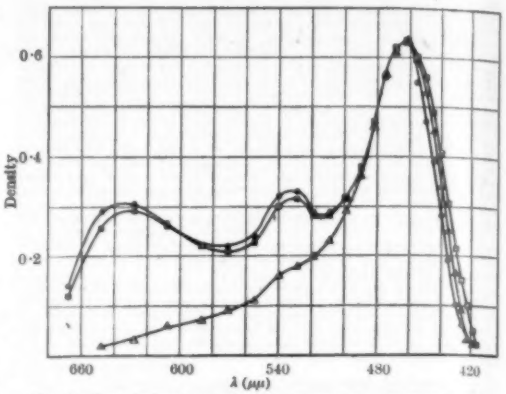

Fig. 3. PHOTOMETER CURVES OF FLUORESCENCE MICROSPECTROGRAMS OF A THIAMIN SOLUTION, ⊙; OF THE MYELIN SHEATHS OF THE ISCHIADIC NERVE IN RABBITS, □; AND OF THIOCHROME, △

of cells in tissue sections. The method makes possible a detailed analysis of the fluorescence spectra and an accurate location of the maximum in the fluorescence bands, which is necessary in order to identify the fluorescent substances under the conditions in question.

With the aid of this method, it has been possible cytologically to localize riboflavin and thiamin. In the frog's eye, riboflavin is thus distinctly localized to the chorioides; but it has hitherto not been possible to demonstrate its presence in the layers of ganglion cells, the visual cells or the pigment epithelium. Fig. 1 shows fluorescence spectra from a solution of pure riboflavin in normal acetic acid and from the chorioides of the frog's eye upon micro-extraction with normal acetic acid. The deviations in the position of some of the measured points are within the limits of the accuracy of measurement in this case.

This localization of at least the major part of riboflavin does not agree with that found by v. Euler, Hellström and Adler[1] in fish eye (pigment epithelium), which, if there is no fundamental difference between fish eyes and frog's eyes, may be attributable to the fact that in the present study an improved fluorescence microscopic method has been used[2] allowing of a more accurate orientation in the histological sections.

Thiamin has been localized quite distinctly in the myelin sheaths of peripheral nerves. Fig. 2 is a fluorescence photomicrograph of the ischiadic nerve in rabbit. The myelin sheaths have a strong bluish-white fluorescence owing to thiamin spontaneously oxidizing to thiochrome. Fig. 3 shows photometer curves of fluorescence microspectrograms of a thiamin solution, of the myelin sheaths of the ischiadic nerve in rabbit, and of a thiochrome solution. The common maximum at 460 mμ is ascribed to thiochrome, which is formed also in thiamin preparations by spontaneous oxidation. The three fluorescence spectra were photographed under exactly the same conditions on the same film, and they are consequently mutually comparable.

By the localization of these vitamins, indirect information can be obtained regarding the localization of the ferments in which they occur as active groups.

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Pure Cultural Observations on Bacterial Infiltration of the Appendix in Rabbits

DIRECT microscopical observation demonstrates an abundant infiltration of the lymphoid nodules of the appendix by the bacteria present in the lumen[1]. Large numbers of these, the majority of which are strongly iodophile, are taken up by the exceptionally well-developed macrophage system. Recently this infiltration has been investigated by pure cultural methods.

The tip was excised from the appendix of a freshly killed rabbit and the fragment, consisting of about three lymph nodules and a little muscularis, was inoculated on to suitable media. Sections were cut to demonstrate that the lumen was unopened and for the purpose of studying the morphology of the organisms present. The typical histological picture was found in each appendix.

The organisms isolated were of two groups, Gram-negative aerobic bacilli and Gram-positive aerobic spore-bearing bacilli; the majority were facultative anaerobes and, with one unidentified exception, were motile. Of the former group *Bact. coli commune* and *Bact. acidi lactici* of fæcal type were identified. Precise identification of the strains in the latter group was difficult owing to the lack of absolute differential criteria[2,3], and the great variation that may occur within a species as accepted by the authors of some of the original descriptions[4]. The morphological characters, nutritional requirements and biochemical reactions make it likely that they are of the *Bacillus* (Cohn) group.

Strains closely resembling the following species were obtained: *B. arenarius, B. vulgatus, B. panis, B. bortelensis, B. fusiformis.*

In the sections, the ingested and intracellular organisms were Gram-positive bacilli of varying sizes; many were spore bearers, and cells showing partial decolorization and irregular outline, probably implying digestion, were seen. One very large bacillus was present which resembled none of the strains isolated; spores were not demonstrated. The majority of these organisms, including the large bacillus and all types of spore bearers, gave the typical blue reaction with iodine[5].

Comparisons with the morphology of the strains cultured makes it appear highly probable that they include at least some of the species that *in vivo* are iodophile. So far, all attempts to render them iodophile *in vitro* have failed, but this reaction is still being investigated. It seems that these strains may be common organisms of the *Bacillus* group, and that under *in vivo* conditions they acquire the capacity for polysaccharide synthesis.

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Maximum Rate of Selection for Dominant Quantitative Genes

THE following formulæ are proposed to measure the maximum rate of progress of selection for dominant quantitative genes. To simplify the problem, certain assumptions are made: (1) Selection begins in the F_2 generation of a cross between two pure lines. (2) All genes are dominant in the positive direction. (3) Environmental effects are ignored, selection always being for the phenotypic class of maximum expression. This determines the maximum rate of progress, which would never be attained in actual practice. (4) All genes have either equal additive effects, when data are treated arithmetically, or equal geometric effects, when data should be treated logarithmically.

Let k be effect of each gene; n the number of genes segregating; $n = 0$ represents the mean of the F_2 generation in all cases; g is generation of selection; P is mean of selected generation minus mean of F_2 generation.

Then P increases with the generation of selection and the number of genes segregating, but the formulæ for determining P will vary according to the system of breeding.

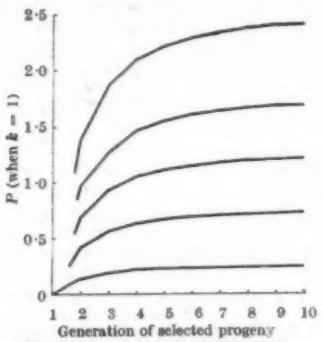

Fig. 1. RANDOM-BRED POPULATION

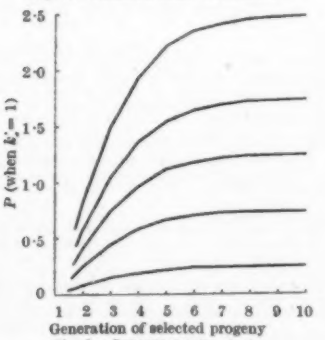

Fig. 2. INBRED POPULATION

In a random-breeding population,

$$P = nk\left\{\frac{(g+1)^2-4}{(g+1)^2.4}\right\}; \quad . \quad . \quad . \quad . \quad \text{(i)}$$

the distribution of each generation being

$$\{1+(2g+g^2)\}^n. \quad . \quad . \quad . \quad \text{(ii)}$$

In a self-fertilized population,

$$P = \frac{nk(2^g-2)}{4.(2^g+2)}; \quad . \quad . \quad . \quad . \quad . \quad \text{(iii)}$$

the distribution of each generation being

$$\{1+(2^g+1)\}^n. \quad . \quad . \quad . \quad . \quad \text{(iv)}$$

Figs. 1 and 2 illustrate graphically the rate of progress of selection for $n = 1 \rightarrow 10$ for random breeding and inbreeding respectively.

It is doubtful whether such formulæ could be used to estimate numbers of genes from experimental data. They are of value, however, in demonstrating that selection for quantitative characters may proceed, after a few generations of rapid progress, by steps which are only a small fraction of a single gene difference. The relative size, $k = 1$, of a single gene difference, that is, the difference between *aa* and *AA*, is shown in the diagrams. It should be noted that the mean of an F_2 generation, when all genes are dominant in one direction, is $\frac{3nk}{4}$; this has been adjusted to 0 in the above discussion.

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March 7.

Control of *Boophilus australis* in the Argentine by the Gamma Isomer of Hexachlorocyclohexane ('Gammexane')

DURING the last ten years or so, difficulties have been experienced in the Argentine in obtaining complete control of the common cattle tick, *Boophilus australis* (syn. *microplus*). Similar difficulties have been observed in other countries, especially South Africa, where arsenical resistance is stated to have been proved.

Recent trials were carried out with dips containing the gamma isomer of hexachlorocyclohexane ('Gammexane') and the results show that complete tick control can be obtained.

At bath concentrations of 1 : 50,000, 1 : 33,000 and 1 : 17,000 of the gamma isomer, the number of ticks per animal is substantially reduced. Furthermore, the oviposition of engorged females is somewhat reduced, though the proportion of larvæ emerging from the eggs is usually more than 95 per cent. At 1 : 8,000–1 : 4,000, practically all engorged females drop off the animals within the first 24 hours after dipping, and all small females, males and larvæ are either killed or very affected. Six days after a double dipping at 1 : 4,000 of the gamma isomer in the wash the animals were free of tick, but not those dipped at 1 : 8,000. At these concentrations oviposition of the engorged females was still not greatly reduced, and 95 per cent or more of the eggs hatched normally. A double spraying with washes containing 1 : 1,700 and 1 : 830 of the gamma isomer not only cleaned the animals but also affected the engorged females and completely prevented oviposition.

Trials in which the isomer was incorporated with a plain arsenical dip with 0·2 per cent As_2O_3 showed that at 1 : 17,000 oviposition was very incomplete and a high proportion of the eggs was sterile. At 1 : 8,000 all the engorged females detached themselves within 24 hours and no oviposition took place. A single dipping with these two preparations did not completely clean the animals, but at the higher concentration of the gamma isomer control was very satisfactory.

Concentration of gamma isomer	Animals freed of ticks	Oviposition	Eggs hatching (%)
1 : 50,000	Not in a single dipping	Abundant, but incomplete	98
1 : 33,000	" "	"	80
1 : 17,000	" "	"	98
1 : 8,000	Not with double dipping at 14 days interval	"	95
1 : 4,000	Clean 6 days after double dipping at 14 days interval, but result not constant	"	98
1 : 1,700	Clean 5 days after second dipping at 14 days interval.	None	—
1 : 830	" "	None	—
0·2% As_2O_3 plus 1:17,000	Not in a single dipping	Very incomplete	Practically none
0·2% As_2O_3 plus 1 : 8,000	Almost complete in a single dipping	None	—
0·2% As_2O_3 alone	Not after several dippings at 8–14 days interval	Incomplete	Up to 66, from ticks collected the 7th day after dipping

as five days after the dipping only 1–2 nymphs in moult were observed. A second dipping at 8–10 days interval would almost certainly have given complete control.

These results indicate that 1 : 1,700 of the gamma isomer alone or a 1 : 8,000 concentration as an addition to a plain arsenical dip with 0·2 per cent As_2O_3 will give complete control of the tick : a result that cannot at present be obtained by the arsenical dip alone. The nymphs in moult, however, are not sufficiently affected to obtain control by one dipping.

No adverse effects on the animals were observed, due to the 'Gammexane'.

C. N. AULT

Wm. Cooper & Nephews (S.A.), Ltd.,
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April 29.

Artificial Fertilization of Cod (*Gadus callarias* Linn.) at Port Erin

THE remoteness of most cod-fishing grounds from marine stations renders the accomplishment of the artificial fertilization of the cod (*Gadus callarias* Linn.) at Port Erin of considerable interest, particularly in relation to the experimental possibilities of investigating the variability exhibited by this species in different geographical regions[1].

This year the cod fishing has been productive off Port Erin, and acting on reports that the fish were running ripe, instructions were given to the fishery assistant, Mr. Kenneth Woodworth, to make artificial fertilization of the cod at sea by two methods, both of which were successful. Five successful fertilizations were made simply by means of squeezing eggs from a freshly caught running ripe female into a large bottle half-filled with sea water, afterwards adding milt from a freshly caught running male. One fertilization—also successful—was made by the dry method used for salmon, that is, eggs were shed into an empty bottle with the addition of milt and, fifteen minutes later, sea water.

The fertilized eggs were quickly transferred to the Marine Biological Station on the arrival of the boat in harbour, and were well washed with sea-water and kept under circulation by the admirable technique of the hatchery boxes in use at the Port Erin Station[2]. The mortality was high in the earlier experiments but low in the later ones with improved technique. Young fish hatched after ten days incubation at a mean temperature of 8·3° C. and mean salinity of about 33‰. Segmentation into two blastomeres occurred after 5 hours, into four after 6¼ hours, eight at 7½ hours, sixteen at 8½ hours. The eggs ranged in size from 1·22 mm. to 1·44 mm. with a modal size of about 1·3 mm. Further details will be given in later publications.

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M. P. MOTWANI
J. H. ORTON

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Port Erin, Isle of Man.
April 12.

[1] Schmidt, J., *C.R. des Trav. Lab. Carls.*, **18**, No. 6 (1930).
[2] Herdman, W. A., 22nd Ann. Rep. Mar. Biol. Stat., Port Erin (1908).

Neotypes for Species Based on Pathological Specimens

IN a recent discussion on "The Naming of Pathological Specimens", Dr. L. F. Spath[1] arrives at the conclusion that a species based on such a specimen must be considered valid. No exception can be taken to this conclusion, but Spath's view that "a normal type [can] obviously not be chosen while the holotype [is] still in existence" might well be questioned.

G. G. Simpson[2] lists aberrance of a specific type explicitly among the cases in which "what is known about a specific type is . . . ambiguous". Such a type "fails to serve its purpose" (p. 29 of ref. 2) and has, therefore, to be replaced by a—normal—neotype.

Selection of that neotype devolves upon the student who first recognizes the pathological character of the holotype upon comparing it with normal specimens considered conspecific by him.

OTTO HAAS

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New York 24, N.Y.
March 19.

[1] *Geol. Mag.*, **82**, 251 (1945).
[2] *Bull. Amer. Mus. Nat. Hist.*, **85**, 30 (1945).

Factorial Analysis of Colour Vision

HOUSTOUN[1] has pointed out that a three-colour theory, such as that of Young and Helmholtz, inevitably leads to mathematical contradictions. It is well known in addition that a theory in which there are only three primary sensitivities, such as red, green and blue, becomes unsatisfactory when the many different forms of defective colour vision are studied in detail. Piéron[2] has recently attempted to meet these difficulties, but only by a complex and speculative hypothesis. Chapanis[3] has published results of experiments on variations of the saturations of spectrum colours, which are inconsistent with a three-colour theory.

In experiments at Glasgow, factorial analysis has shown interesting results. From combined correlations between measurements of sensitivity to four colours and brightness, using six different tests and 345 subjects with normal colour vision, three factors were extracted. They were : (1) general (which, like other general factors mentioned below, may be interpreted as expressing the subjects' ability to carry out the experiments, special variations of colour vision apart) ; (2) bipolar—red-green ; (3) bipolar—yellow-blue. For 38 red-green blind subjects, who form a statistically distinct group, the factors were : (1) general ; (2) bipolar—yellow-blue ; (3) inadequate evidence of a third factor. The axes were not rotated.

In another test, using eight monochromatic filters and purple, similar results were obtained with 175 normal subjects. The factors were : (1) general ; (2) bipolar—red-green ; (3) bipolar—yellow-blue. For 23 red-green blind subjects in the same experiment, however, the factors were : (1) general ; (2) bipolar—yellow-blue ; (3) bipolar—red + green *versus* yellow + blue. This shows the tendency for red and green to be identified in the red-green blind, but still to vary separately from yellow. It was interesting to compare these results with factorial analyses for two other statistically distinct groups, although the numbers were small. Nine green anomalous subjects gave the following factors : (1) general ; (2) bipolar—yellow-blue ; (3) bipolar—red-green. Three red anomalous subjects gave : (1) general, with a negative loading for red ; (2) bipolar—yellow-blue ; (3) bipolar—red-green. In all these experiments the brightness-level correlated positively with the general factor, with the blue side of the blue-yellow factor and with the green side of the red-green factor.

In a further experiment with monochromatic filters on 61 normal subjects, in which the colours were desaturated with their neighbours on the colour circle instead of with opposites or complementaries, three factors were obtained. They were : (1) general ; (2) bipolar—red + green *versus* yellow + blue ; (3) bipolar—a factor contrasting colours measured by desaturating each other. The second factor showed that in this experiment red-green sensitivities were being contrasted with yellow-blue. On the Young–Helmholtz or Ladd–Franklin theories, it is inconceivable that in such an experiment red and green should vary inversely with yellow and blue. On a four-colour theory of the Hering or Houstoun type it might be expected.

It appears that the Young–Helmholtz theory gains no support from these experiments, while a four-colour theory would be strongly supported. On such a theory it would appear that the primary sensitivities are red, green, yellow and blue : brightness-level being determined largely by general sensitivity irrespective of hue discrimination, by blue rather than by yellow and by green rather than red. Houstoun preferred peacock or blue-green to pure green. These experiments suggest green in preference to peacock. Factorial analysis strongly indicates that opposing pairs of sensitivities are inversely related : as red decreases, so green increases : and similarly with yellow and blue. Burt[4] has obtained similar evidence. In the Glasgow experiments, in all types of red-green defectives the yellow-blue factor came out second and the red-green factor third, showing the change in relative emphasis of the factors. In the red-green blind subjects, red and green were combined in the third factor and still distinct from yellow.

Houstoun[1] has suggested two types of receptor, each capable of two alternative modes of response, namely, a red-green type and a yellow-blue type. It might be easier to consider four types of receptor, working in pairs, a red-green pair and a yellow-blue pair. The saturation and hue of a given colour mixture would then depend on the proportions in which the receptors were excited. In the red-green blind there might be a tendency for the red and green receptors to be excited by both red and green rays, and the degree of red-green blindness would then correspond to the degree of this failure of differential response. In the red and the green anomalous subjects, the position rather than the sharpness of change-over from mainly red to mainly green responses is affected, and a mixture of red and green light appears to them yellow in proportions widely different from those required by the normal subjects, though their colour discrimination in daily life is not greatly affected. On this general theory, brightness would be accounted for mainly by an independent system and partly by variations of green and of blue for normal subjects (while for those red-green defectives with darkened red vision it would also be affected by red).

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March 26.

[1] Houstoun, R. A., "Vision and Colour Vision", chapter 14 (1932).
[2] Piéron, H., "La Sensation : Guide de la Vie", pp. 152ff (1945).
[3] Chapanis, A., *J. Exp. Psych.*, **34**, 24ff (1944).
[4] Burt, Cyril, *Eug. Rev.*, **37**, 154 (1946).

Lantern Slides of Diagrams, Formulæ, etc.

FOR the past five or six years I have been using a method for making lantern slides of line drawings which is easier and cheaper than that indicated in *Nature* of Nov. 10, 1945, p. 574 [see also *Nature*, May 4, 1946, p. 591].

Take a clean lantern slide and coat it with egg albumin by allowing white of egg to run over it ; one egg will suffice for about twenty slides. Stand the slide against the wall for three or more hours to dry, taking care that dust does not fall on it. When it is sufficiently dry, it is fairly easy to write on it with ordinary indian ink of any colour.

An alternative method is to coat the slide with a thin solution of Canada balsam, just enough to cover the whole slide : run off excess Canada balsam, and stand the slide to dry. Use indian ink.

Recently I have been using a still simpler method. Clean the slide until all traces of grease or fat have been removed, and dry it. Using any of the common glass inks, one may write directly without coating the slide.

Apart from the saving in cost and time by any of these methods, the luminosity of these slides is such that they can be projected in a room with practically all the windows fully open or with most of the electric lights burning in the room. This has proved very practical during lectures, as students can see the screen and make notes of the slide diagram or text. Here in Bombay the cost of slides prepared by any of these methods is about 2*d*.–3*d*. each. With a little practice it is an easy matter to prepare biological slides, chemical formulæ, etc.

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RESEARCH ITEMS

Houses of the Sierra Tarascans

"Houses and House Use of the Sierra Tarascans" by R. L. Beals, P. Carrasco and T. McCorkle (Smithsonian Institution. Institute of Social Anthropology, Pub. No. 1) is the first of a new series which is to attempt to reconcile scientific and applied objectives in anthropology. Housing is not only a subject of consideration in social welfare but it is also an important aspect of culture, and is therefore a suitable topic for a study of this sort. The Tarascan Indians of Mexico form a large group of whom not much is known scientifically, though there are records of them from the sixteenth century, when they are known to have occupied much more territory than they do now. Their towns are usually situated on level ground, though there are some mountain villages, and the houses are built of wood or of adobe bricks and stone masonry. House building is done by special workmen and the materials are local; fir, or preferably pine wood is used for the timber and is cut into beams, planks and 'shakes' for roofing. The adobe bricks are made of earth mixed with manure and water to a proper consistency and then shaped in wooden forms; the masonry consists of assorted rocks which are roughly trimmed. Following this description of the materials used, there is an account of the types of buildings: the house, really a storehouse; the kitchen, which sees most of the family life; and the shed for animals or fodder. Cooking is done on a hearth on the ground, with stones (usually six) to support the cooking vessels, which are made of clay. The other house furnishings are on an equally primitive level with the exception of occasional imported implements. The building costs of this type of house are estimated and its ceremonial and social function discussed, and there is also a short historical account of Tarascan houses. The paper is illustrated with drawings and photographs.

Rh Factors and Feeble-mindedness

L. N. Snyder, M. D. Schonfeld and E. M. Offermann (*J. Hered.*, **36**, 9; 1945) have described data which are suggestive that the incidence of feeble-mindedness is significantly correlated with the *Rh* factors. They follow up the evidence of Yarnell and Lieberman with further data. The combined data show an excess of *Rh*-mothers among mothers of feeble-minded children, and of feeble-minded children from *Rh*-mothers. The proof of the effects of the immunization upon brain tissue will depend on the discovery of erythroblastosis and feeble-mindedness in the same family.

Sympathetic System and Water Diuresis

W. J. O'Connor and E. B. Verney (*Quart. J. Exp. Physiol.*, **31**, 393; 1942) have shown in dogs that the inhibition of water diuresis which follows emotional stress is due to the liberation of antidiuretic hormone from the posterior lobe of the pituitary gland. 'Emotional stress' was produced by electrical stimulation of the skin. In further work (*Quart. J. Exp. Physiol.*, **33**, 77; 1945) they found that such inhibition occurred only in about one third of all tests on normal dogs; but in dogs after denervation of the kidneys with section of the splanchnic nerves and removal of the second, third and fourth lumbar sympathetic ganglia on both sides, inhibition occurred in all tests. In such 'denervated' dogs inhibition of diuresis could be prevented by injecting adrenaline just before the application of the electrical stimulus. Adrenaline injection, however, did not affect the inhibition produced by injection of posterior pituitary extract, and so it was concluded that adrenaline acts by preventing the release of antidiuretic hormone from the pituitary. The fact that emotional stress did not cause an inhibition of diuresis in many of the tests on normal dogs could therefore be accounted for in terms of increased sympathetic activity resulting from emotional stress. In the course of this work, O'Connor and Verney observed another type of inhibition of water diuresis which may follow emotional stress in normal dogs. This type of inhibition is much more rapid and evanescent than that due to antidiuretic hormone, and it is completely abolished by section of the splanchnic nerves with denervation of the kidneys and suprarenals. This rapid inhibition is probably due to renal vasoconstriction, though the evidence here is not yet complete.

A Portable Instrument for Recording Human Respiration

A NOVEL apparatus for recording respiration in human beings has been devised by Mr. Ralph Poole, 50 Bedford Square, W.C.1. It comprises an ordinary breathing-mask or face-piece attached by flexible tubing to an air-flow meter. The air-flow meter consists of a light spring-controlled vane working in a suitably shaped chamber. Attached to the vane spindle and moving with it is the secondary coil of a small transformer the fixed primary coil of which is fed by A.C. at 12 volts, obtained by stepdown from the mains. The secondary coil is connected to a recording voltmeter and the induced voltage is proportional to the deflexion of the vane. The air-flow meter is strapped to the subject, and trailing leads connect it to the A.C. supply and the recorder, which may be any distance away. The advantages of this instrument are the negligible resistance offered to breathing and that recording may proceed while the subject is performing any type of work. Unfortunately, its usefulness is limited by the fact that it records only the velocity of tidal movements and not the absolute tidal volumes.

Lettuce Mildew in China

THE fungus *Bremia lactucæ* causes a disease of lettuce and other species of Compositæ, over wide geographical regions. Lee Ling and M. C. Tai have studied the specialization of this fungus in China (*Trans. Brit. Mycol. Soc.*, **28**, 16; 1945). *Lactuca chinensis*, *Sonchus oleraceus*, *Taraxacum mongolicum* and *Crepis japonicus* are all infected with physiological forms of *Bremia lactucæ*, and no interinfection takes place. *Lactuca sativa* and *L. indica* share a further physiological species. *Saussurea affinis* is attacked by a species of *Bremia* with spores much larger than *B. lactucæ*, and is regarded as a separate species, *B. Saussureæ*.

Genetics of Yeast

A varied series of fundamental problems is raised by a further paper on yeast by S. Spiegelman and C. C. Lindegren (*J. Bact.*, **49**, 257; 1945). They show that adaptability to ferment galactose can take place in the haplophase by mutation, and that the absence or extreme reduction of this stage in some species prevents the appearance of these mutations. They also show that there are a few strains which have not mutated in the haplophase towards the ability to ferment galactose, although they mutate freely for other characters. The authors find that the presence of a small amount of glucose is necessary

in the early stages to permit the galactose non-fermenters to start growth and then to be selected for mutations of fermenters of galactose. Little reliance can be placed upon physiological characters for classification in yeast, and there is considerable danger in depending upon yeast for biological assay as has been done for the estimation of galactose in the presence of other carbohydrates. The recent papers upon the genetics of yeast shed light upon the vexed question of neo-Lamarckianism.

Magnesium Chlorosis

T. Walsh and E. J. Clarke have made the interesting suggestion that a chlorosis of tomatoes due to magnesium deficiency should be controlled by attention to the level of potassium, rather than by the addition of magnesium compounds (*J. Roy. Hort. Soc.*, **70**, Pt. 7; 1945). They show that the chlorosis is associated with high values of potash, that its appearance depends largely on the ratio of potassium to magnesium, and that high concentrations of mineral nutrients in the soil lower the yield of tomatoes. There is an increasing volume of evidence, apart from that presented in this short paper, that the tomato crop is often over-manured. Additions of magnesium compounds would only add to this difficulty, and there appears to be sufficient magnesium for good growth in the Irish soils investigated, when the potash is kept at a suitable level.

Carbohydrates in Grains of Wheat Grafted on Rye Endosperm

W. E. Pissarev and N. Vinogradova have succeeded in growing wheat plants by transplanting embryos of wheat kernels on to rye endosperms. The plants were grown until fully ripened and producing seed, which differed from the control in certain morphological features. A. A. Schmuck (*C.R. Acad. Sci. URSS.*, **44**; 1944) has studied the grafted grains biochemically and found them to have only somewhat higher nitrogen and protein content and less starch than the controls; there was, however, a sharp difference between the two in the gluten. The gluten from grafted grain was dark-brown instead of the usual light-pink colour. Further distinction was found in the quantity of trifructosane, $C_{9}H_{20}O_{18}$, which is practically absent from normal wheat grains but quite considerable in the grafted wheat, as it is also in rye grain. Thus, the grain of wheat grafted on rye endosperm proved to contain a carbohydrase which is typical of rye. The nutrition of the growing scion in the earliest stages appeared to determine the subsequent profound biochemical changes in the mature plant.

Fruit Development in the Peanut

A REPORT from Dr. J. Needham, in China, concerning investigations made by Cherng-How Lou and Chin-Hsu Liu (of the Physiological Laboratory, Tsing Hua University, Kunming, China) on the development of the fruit of the peanut, *Arachis hypogea*, has recently been received. It will be recalled that after fertilization, the 'flower stalk' elongates carrying the ovary downwards, the corolla, with the stamens, having fallen off. The sharp style grows into the soil and the thick pericarp of the pod develops. In the air, the ovary does not develop unless light be excluded. Allard (1932) had previously shown that the related hog peanut (*Falcata comosa*, L.) reacted to controlled periods of daylight in regard to the hypogean flowers and fruits, and the cultivated peanut is in general comparable. Chin-Yueh Chang (University of Peking) has studied the morphological changes in the ovary stalk, or gynophore, leading to the regeneration of meristematic tissue, later concerned with phases of its rapid elongation. The newer investigations deal with the removal of the tip of the gynophore, consisting of the undeveloped fruit and a very short length of the underlying tissues, in all some 2 mm. in length. Using this as a 'scion' they were successful in more than 50 per cent of their attempts to graft the excised portion on to the stems of the cotyledons of seeds starting to germinate; or in other instances on to the cotyledons. Given suitable conditions, union of these tissues took place followed by the growth of the gynophore and succeeded by the development of the fruit in darkness. These cotyledons thus supplied directly, through the gynophoric tissue, nutrients for other enlarging fruits and their seeds. Grafts were not successful when the 'scions' were placed on to similar tissue of lupins, soy-beans, or other related plants.

Effect of Drying on Nitrogen Oxides

IT has been believed that intensive drying with phosphorus pentoxide alters the physical properties (boiling point, vapour pressure, vapour density, and surface tension) of liquids. In the case of dinitrogen tetroxide, an increase of vapour pressure was found, which was ascribed to a shift of the equilibrium $N_2O_4 \rightleftharpoons 2NO_2$ to the right in the liquid. E.M. Stoddart (*J. Chem. Soc.*, 448; 1945) finds that the liquid reacts slowly with the phosphorus pentoxide even at room temperature, forming a compound $P_2O_5.2NO$ and liberating oxygen, which causes an increase of pressure. The dried liquid has a normal vapour pressure. The increase in vapour density reported for vaporized dried dinitrogen trioxide is also due to this compound, which withdraws NO from N_2O_3 and leaves a gas richer in N_2O_4. These results, together with results of other workers on boiling points, surface tension, liquid density and dielectric constant, lead to the general conclusion that drying does not influence the physical properties.

Planetary Perturbations

"La Aceleracion Secular De Los Ejes Mayores De Las Orbitas Planetarias" is the title of a thesis by Alexander Wilkens (*Observ. Astron. Univ. De La Plata, Ser. Astron.*, **18**). As the work contains nearly two hundred pages of which the greater portion consists of abstruse formulæ, it is impossible to do more than indicate the general lines of investigation. The earlier part of the thesis shows how it is possible to develop the elements of a planetary orbit in powers of the perturbing mass and also how differential equations in terms of the third order of the semi-major axis are formed. Then it is shown how secular terms of the third order of the semi-major axis, proportional to powers of the time, t and t^2, are obtained. In the first instance, this is restricted to the cases where the orbit of the disturbing body lies outside that of the perturbed body, and the effect of one planet only on another is considered. Later, however, the thesis shows how the method can be extended to cover the total perturbations of the major planets. Finally, the method for computing the perturbations when the perturbing body lies inside the orbit of the perturbed body is dealt with. The second part shows how the Poisson terms, of the form $t^2 \cdot \begin{matrix}\cos \\ \sin\end{matrix} A$, are deduced.

ARMSTRONG-WHITWORTH TAILLESS GLIDER

INFORMATION has just been released that an experimental glider of the 'Flying Wing' type, known as the A.W.52G., has been in operation since March 1945. It was designed and built in Messrs. Armstrong-Whitworth's works for experiment upon the behaviour of this kind of aircraft in those respects in which only full-scale tests give reliable data, particularly control and stability, without the more conventional tail surfaces. Experience gained upon this will be used possibly for the design of larger tailless machines of multi-engined and jet-propelled types. Flying has been carried out by Mr. C. Turner-Hughes, followed by Mr. E. G. Franklin, and the design was due to the firm's chief designer, Mr. J. Lloyd.

The general layout of the machine is a monoplane of broad 'Vee' plan form, the wings having a sweep back on the leading edges of 30°. The wing span is 53 ft. 4 in., and the chord is 12 ft. 4½ in. at the root, with a considerable taper to the tips. Rudders and fins are carried on the wing tips. It is probable that this glider could have been flown without rudders, but knowledge of their behaviour was needed for the design of a larger multi-engined aircraft, that would need them to correct yaw due to failure of one of the engines. The principal control is obtained by a combination of trailing edge flaps and tabs, modified by correctors, controllers, and spoilers, an arrangement of extremely novel type. The construction is of wood, and a smooth and non-varying profile form is obtained by making the skin of 'Plymax', which is plywood with light alloy sheet bonded together.

A test glide is made by towing the machine to about 12,000 ft. altitude and releasing it. The resulting glide to earth takes about twenty-five minutes, and most of the observations are taken by recording instruments and photographic records taken with specially designed cinematograph cameras.

It is probable that whatever the results work out to be for propeller-driven machines and to-day's speeds, wings with a pronounced sweepback will be a necessity with jet propulsion at supersonic speeds, to delay the onset of compressibility. The wing tips, being so far back, may conceivably be able to carry the directional control surfaces efficiently, and the drag and weight of the conventional tail and its supporting girder avoided. The absence of a tail may also help the closer grouping of multiple-jet power units nearer the centre line of the aircraft, which will reduce the offset pull due to the failure of one of them. The close grouping of the engines is limited nowadays by propeller diameter; but this trouble is avoided with jet propulsion.

TRANSFORMER OILS

A GENERAL discussion on transformer oil, organised by Mr. E. A. Evans, vice-president of the Institute of Petroleum, was held at the Institution of Electrical Engineers on April 9.

P. W. L. Gossling and A. C. Michie, in presenting the contribution of the British Electrical and Allied Industries Research Association to international research on transformer oils, pointed out that so long ago as 1926 the Advisory Committee of the International Electrotechnical Commission arranged that comparative tests on samples of identical oils should be carried out by the various standard national methods. So it was apparent in those days that a serious effort was being made to develop an international standard method for the examination of insulating oils. In 1930 the Committee appointed delegates to study the factors influencing the oxidation of oils, because it was clear that the methods of test were handicapped by insufficient knowledge of the subject.

The British Standard Specification 148 was a bold attempt to formulate the requirements of transformer oils for the British market. That specification has been subject to revision, but in principle it remains substantially as it originally stood. Of course it had critics. So, in 1935 the International Electrotechnical Commission submitted a questionnaire to the international committees inquiring for the principal causes of trouble in transformers. The British reply was that; prior to the introduction of B.S.148, breakdowns were mainly attributed to sludge; but since its introduction this type of breakdown had been practically eliminated. The replies from other countries indicated that sludge was the most troublesome.

About this time Class A oil, which is virtually a technical white oil, was beginning to lose some of its popularity, due to the alleged acid formation and the risk of corrosion. On the Continent of Europe this type of oil had never been really popular; but the different points of view cannot be wholly separated from the designs of the respective transformers. In Great Britain, varnished windings were much used, whereas in Switzerland bare cotton was exposed to the acid in the oil and was therefore subject to deterioration by generated acidic bodies.

During the last year or two, there have been murmurs about the transformer oil which was available. It was therefore considered prudent to make as complete an investigation as possible so that the post-war programme could be undertaken with the maximum of considered opinions.

J. Wood-Mallock presented a paper on "Some Developments in the Refining of Transformer Oils". He stated that sulphuric acid is still used in refining electrical oils. By increasing the treatment with the acid the tendency towards acid production on ageing increases; therefore it is well understood that if an oil is generously treated with sulphuric acid it will have a greater tendency towards acid formation, and possible corrosion. But, when liquid sulphur dioxide is used as a refining agent, an oil is produced with much reduced tendency towards acid formation. This seems to be true, even with an increase in solvent dosage. On the other hand, a reduction in sludging value is obtained by increasing the degree of acid treatment.

In this very well-reasoned paper Wood-Mallock produced evidence that by certain treatment the natural inhibitors are removed and that during refining pro-oxidants can be introduced. In fact, an oil containing 0·0014 per cent ash consisting principally of calcium sulphonate would give a sludge value many times that of an oil from which this material was absent. So refiners are faced with the difficulty of retaining the anti-oxidants and avoiding or removing the pro-oxidants. If it is difficult to evade these two problems, then it is natural to turn to anti-oxidants.

P. George and A. Robertson, of the Department of Colloid Science, Cambridge, gave "A Review of the Mechanism of the Oxidation of Liquid Hydrocarbons".

They indicated that oxidation does not occur at the unsaturated bond, according to the long-accepted theory, but at a C—H bond. Hydroperoxides are formed and can be isolated in certain cases. After the preliminary formation of a hydroperoxide, the course of the oxidation is governed by its decomposition. There is much evidence that ketones are the key decomposition products from which the more highly oxidized compounds are derived. Hydroperoxide formation in both thermal and catalysed reactions proceeds by a chain mechanism. Whereas the catalysed reactions involve free radicals as the chain carriers, there is some evidence that in the thermal reaction the chain carriers can be free radicals or energy-rich molecules, depending on the particular hydrocarbon which is oxidized. In the uncatalysed oxidation the auto-catalytic increase is due to a hydroperoxide catalyst reaction developing side by side with the thermal oxidation.

It should not be too difficult, now that our knowledge of oxidation is improving rapidly, to predict the stability to oxidation of a pure hydrocarbon of known structure. Apparently, the oil starts to oxidize almost uncatalysed, and as acids are produced they gradually dissolve away various catalytic metals and so catalytic oxidation proceeds.

Anti-oxidation has long been known, but there is a shyness, or perhaps distrust, towards it among makers of transformer oil.

E. A. Evans stated in his paper that the time is at hand when broad principles must be introduced, studied and applied. Caution can be observed, provided it does not decelerate progress. If oxidation of transformer oil is objectionable, any method by which it can be reduced is worthy of consideration; fear that a method is transitory is insufficient to condemn it. Chemical additives have been introduced and are now standardized in many industries, as well as in certain branches of the petroleum industry, particularly lubricants which are akin to transformer oil. How the petroleum industry is attracted to anti-oxidants is revealed in this paper.

Probably no one is perfectly happy with the many methods which have been suggested for measuring the propensity of an oil to oxidize; but C. H. Barton feels that the sludge test for transformer oils as practised in Great Britain is too unreliable in its present form, and, of course, he gave supporting evidence for his attack.

A. A. Pollitt, in his paper, reviewed the oxidation tests for transformer oil which are practised in other countries and indicated that they possess no general advantage over the British method. This comparison and criticism is a very useful contribution as it emphasizes the difficulties of the problem.

Messrs. Gossling and Romney gave a paper which showed fairly conclusively that even an apparently small difference, such as variation of the water temperature in the condenser, has a profound effect upon the amount of oxidation produced.

Mr. Norris, in the discussion which followed the papers, speaking as a transformer engineer of many years experience, suggested that insufficient attention has been given to the insulating material in a transformer other than oil. He felt that the insulating varnish has a considerable effect upon the decomposition of the oil. His view appeared to be that if varnish were excluded much of the trouble would be eliminated.

Collected information by the Incorporated Municipal Electrical Association was presented by D. P. Sayers. This was based upon replies to a questionnaire issued to twenty-two large municipal undertakings, which have some ten thousand transformers in service ranging in size from 5 kVA. to 4,000–5,000 kVA., aggregating in all more than 6 million kVA. It is significant that in less than 2 per cent of the ten thousand transformers has any acid trouble been experienced. More than 90 per cent of the troublesome transformers were filled with Class A oil. The information received as to the effect on the transformer of high acid values in the oil is far from consistent. The principal effect is on the inside of the lid and tank sides above oil level. Although this occurs with high acid values, instances were given of attack with values less than 1 mgm./KOH. In the majority of cases the acid appears to have no direct deleterious effect on the insulating materials or copper windings. When once acidification has started, however, the process continues.

A. G. Ellis confirmed that sludge is not a matter for much anxiety these days. Acid trouble has been practically confined to Class A oil. Neither C. W. Marshall, who is mainly interested in the Class B oils in large transformers, nor L. H. Welch, whose principal concern is small transformers, had any serious criticisms to make about large transformers. Possibly this is mainly due to the great care taken in their maintenance; small transformers should be given more attention.

R. Weaving reminded the meeting that there was trouble fifteen to twenty years ago, but undoubtedly there has been an improvement in the quality of the oil and in the design of transformers, particularly in the elimination of hot spots or, as the chemist would prefer to say, hot zones. Very few transformers are on full load continuously, therefore we should reconsider the subject of temperature, particularly in the testing of oil. The pre-eminence given to acid at the present time may be one of those cycles of fashion which occur; on the other hand, it may be due to want of appreciation of the value of ventilation.

F. Meyer was of the opinion that too much blame should not be put upon the insulating varnish. After all, there are different kinds of varnish and different ways of processing it.

A full report of the symposium will appear shortly in the *Journal of the Institute of Petroleum*.

WHAT IS THE TRUE SHAMROCK?

By Dr. HUGH O'NEILL

Langlois Herbarium, Catholic University of America, Washington, D.C.

THE earliest mention of the word 'shamrock' in English literature as given by the Oxford Dictionary (**8**, 622–23; 1914) is in Campion's "History of Ireland", 1571. Other early occurrences of 'shamrock' given by the same authority are in the writings of Stonyhurst, 1577; Spenser, 1596; Holland, 1610; Withers, 1613 and 1633; and Moryson, 1617. From these authors it is clear that the plant designated by them 'shamrock': (1) grew in the woods of Ireland; (2) grew in association with water-cress; (3) had a sour taste; and (4) was commonly eaten by man.

Of all the plants wrongly or rightly identified with the shamrock, only one has all these four characteristics. It is the wood-sorrel (wood-sour or wood-sower), *Oxalis Acetosella* L. This plant is certainly

the shamrock of these English authors, and from their usage it has become the shamrock of English literature.

On the other hand, the shamrock commonly worn on St. Patrick's Day is the small hop-clover, *Trifolium dubium* (= *T. minus* Smith). This is the plant generally sent as the shamrock to the United States from Ireland; it is the plant mentioned as the shamrock in the "Encyclopedia Britannica", 14th edition (Article "Clover", 5, 854*d*; 1929) and in the Oxford Dictionary (p. 623), which states that "The name is now commonly applied to the lesser yellow trefoil, Trifolium minus, which is the plant commonly worn as an emblem on St. Patrick's Day".

Various attempts have been made to explain this discrepancy. Perhaps the most widely accepted conjecture in botanical literature is in *Bonplandia* (1, 50–51; 1853. Hannover) under the heading "Vermischtes" where the [London] *Daily Express* is quoted in German translation. Here attention is directed to the fact that Ireland in earlier times was predominantly wooded, that is, it was the habitat of the wood-sorrel. Later, as the woods gave place to cultivated or pasture lands, the wood-sorrel likewise gave place to the white or Dutch clover, *Trifolium repens*, and the name shamrock was accordingly transferred to this inhabitant of the cultivated fields.

This surmise, commonly accepted in botanical circles (for example, Hegi, "Illustrierte Flora von Mitteleuropa IV^{3}": 1306, 1650, 1654; 1924, where *Trifolium repens* is said to be the present-day shamrock), is open to serious objection on botanical grounds and is contradicted by linguistic evidence. While it is safe to assume that Ireland, like all other countries of the cool temperate zone with an annual rainfall of more than fifteen inches, was originally covered mostly with forest, yet it is equally certain that many small areas throughout Ireland never could have supported the growth of trees; for example, areas where the layer of soil was very thin, especially where the ice-sheet of glacial times had denuded the hill-tops or localities where the sub-soil was too porous to hold the abundant rainfall (for example, on moraines, eskers, drumlins and sand-dunes) or districts where the forest-growth was destroyed by man or other agencies. Such areas are the habitats of the clovers which must therefore have been common enough in Ireland even in the earliest times; hence both wood-sorrel and clovers were always common in Ireland; their relative abundance changing from time to time is no reason why the name shamrock should have been transferred from one plant to the other.

A study of the history of plant names shows that people living close to the soil have a very accurate knowledge and nomenclature of the plants of their surroundings and do not readily transfer names from one plant to another so different as the sour wood-sorrel is from the sweet clover, without adding a qualifying adjective that will prevent confusion. Old names for wood-sorrel in English are 'ladies' clover', 'sour trefoil', but not clover or trefoil without the qualifying adjective. Similarly, in German this plant is commonly called 'Sauer-klee' or 'Wald-klee', while 'Klee' alone means clover. Finally, in Irish, 'seamar' or 'seamrog' means trefoil, clover or shamrock; while 'seamar coille' and 'seamar gear' mean respectively wood-clover and sour-clover, that is, English wood-sorrel. Dineen ("Irish–English Dictionary", 2nd edition, Dublin, 1927) correctly states this last plant is "the shamrock of the Elizabethan writers".

Evidently once Campion had mistakenly identified the shamrock as the wood-sorrel, later English authors followed him. In Scotland, however, this mistake did not occur. All early Scotch Gaelic dictionaries translate 'seamar' and 'seamrag' as clover or trefoil, only one of the recent dictionaries giving wood-sorrel as a second meaning. (Shaw, "A Gaelic and English Dictionary", 1780, London; "A Dictionary of the Gaelic Language", 2 vols., 1828, Edinburgh and London, pub. by the Highland Society of Scotland; Macleod and Dewar, "A Dictionary of the Gaelic Language", 1901, Edinburgh, all give trefoil or clover as the meaning of 'seamrag'. "A Gaelic Dictionary", published by E. Macdonald and Co., Herne Bay, 1902, gives trefoil or clover as the meaning of 'seamrag' but adds as a second meaning wood-sorrel.) As a latest, most convincing Scottish source, taken directly from the living language uninfluenced by literature, there is "A Pronouncing Dictionary of Scottish Gaelic, based on oral information of natives born before the middle of the last century in the Glengarry District", by Henry Cyril Dieckhoff, O.S.B., Edinburgh, 1932. Only one meaning of 'seamrag' is given, namely, clover. ("A Pronouncing and Etymological Dictionary of the Gaelic Language", Malcolm Maclennan, Edinburgh, 1925, gives wild clover as the meaning of 'seamair' and shamrock as the meaning of 'seamrag'.)

In Irish dictionaries, trefoil or clover is always given as the first meaning of 'seamrag'. In some works wood-sorrel is given as a second meaning. Conversely, the first Gaelic word given for wood-sorrel is 'seamsog' not 'seamrog'. 'Seamsog' never means clover. In the Irish alphabet the character for 'r' is similar to that for 's'. This resemblance may explain how Campion confused one with the other.

Finally, the word seamar exists in *Old* Irish as semar with the meaning of trefoil or clover (Hogan, Hogan and Macerlean, "Irish and Scotch Gaelic Names of Herbs, Plants and Trees", Dublin, 1900; Alexander Macbain, "An Etymological Dictionary of the Gaelic Language, Stirling, 1911, give 'semmor' as the Early Irish form.)

Regarding the addition of the suffix '-og' to 'semar', George Calder states ("A Gaelic Grammar", Glasgow, 1923) this is a loan 'k' suffix developed from Brythonic sources and in support cites Lewis and Pedersen ("A Concise Comparative Celtic Grammar", 29, Göttingen, 1937). Gerald O'Nolan ("The New Era Grammar of Modern Irish", 232, No. 18, Dublin, 1934) discusses '-og' as a suffix.

There is no evident earlier trace of 'semar' than Old Gaelic. Welsh, Cornish and Breton dictionaries show no Brythonic cognate for semar or seamrog. Further, no Indo-european root is given by Pokorny (Alois Walde, "Vergleichendes Wörterbuch der Indogermanischen Sprachen", Berlin and Leipzig, 1927–32) for the word shamrock. It may possibly be a pre-Celtic word. There seems to be no evidence of Druidical use of the shamrock as an emblem or in association with any ritual. Clover-leaf needles or stilettos (Klee-blatt Nadeln) have been found in the Pyrennean Megalithic Period or early Bronze Age in France (Ebert, "Real Lexicon d. Vorgeschichte IV^{1}", 30; 1926), but can scarcely be construed as predecessors of the shamrock as an emblem. Dineen (*op. cit.*) offers the interesting suggestion that the shamrock is "possibly a survival of the trignetra, a christianized wheel or sun symbol".

The antiquity in historic times of the emblematic use of the shamrock is established by the Rev. James

Forrestall in "The Shamrock Tradition" (*Irish Ecclesiastical Record*, 36, 63, 1930, Dublin).

As to which species of clover is the shamrock, the overwhelming majority of the Irish consider the small yellow-flowering trefoil as the shamrock. This usage of the people of Ireland has the force of a living tradition and outweighs the evidence of some of the dictionaries and lexicons which refer the shamrock to *Trifolium repens*, the white or Dutch clover. Botanical names, unless used by systematic botanists, are often misapplied. The plant meant by the people of Ireland has much greater claim to accuracy than a botanical name in a dictionary. Mgr. Patrick Nolan, Lakeland, Florida, recalls that as a boy in Belfast he learned to distinguish the shamrock from the clover (*T. repens*) by the white spots commonly shown on the leaves of the latter. *T. dubium* does not have white-spotted leaves.

To sum up: the shamrock of Irish and Scotch Gaelic language and literature and tradition is a clover, in the living tradition of the Irish, *Trifolium dubium* Sibth. The shamrock of English writers is the wood-sorrel.

NEW CROP VARIETIES

NEW introductions from Sweden, Denmark, Holland, France, Canada and the United States are included among the 163 distinct varieties and strains of crop plants now being tested by the National Institute of Agricultural Botany, Cambridge. Many very promising varieties have been submitted by private and 'official' plant breeders working in England, Wales, Scotland and Northern Ireland. In order to give the varieties every opportunity of demonstrating their merits, the fifteen principal yield trials are repeated at centres as far apart as Newcastle-on-Tyne, Bridgwater, and Wye (Kent).

To secure accurate yield results the Institute normally includes each variety in eight different plots, while seasonal effects are overcome by continuing the trials for three seasons in succession. Among the 98 varieties included in special observation plots are fourteen French varieties of wheat submitted by the Syndicat des Producteurs de Semences Selectionnées which are growing alongside the well-known variety Bersee.

Resistance to attacks of such diseases as yellow rust and loose smut, as well as 'lodging' of the straw in cereals, are carefully watched, and the most successful varieties will be promoted from observation plots to yield trials in 1947.

The quality of the resulting crop is carefully studied in co-operation with interested authorities such as the Cereals Research Station at St. Albans, and the Institute of Brewing. The progress made in the breeding of higher quality varieties of oats, wheat, barley, potatoes and sugar beet, etc., is largely the result of careful testing of older varieties in past years.

Apart from the headquarters trial ground at Cambridge, three of the pre-war testing stations are now in full progress at the Harper Adams College (Shropshire), Cannington Farm Institute (Somerset), and the Norfolk Agricultural Station at Sprowston. New regional stations have been established with the approval of the Ministry of Agriculture at the following centres: King's College Farm, Nafferton, Newcastle-on-Tyne; Midland Agricultural College Farm, Loughborough; Hampshire Farm Institute at Sparsholt; and the South-Eastern Agricultural College at Wye. In Yorkshire, trials have been distributed between the Askham Bryan Farm Institute and selected farms in the Wolds and Holderness districts of East Riding.

Combine harvesters will be used to harvest many of the trials in Cambridge, Norfolk and Yorkshire. The 'Combine' enables additional trials to be conducted on farms possessing soil or climatic conditions which are of special interest but which are situated at some distance from a testing station.

The following members of staff have recently been appointed to the National Institute of Agricultural Botany: Mr. J. C. Cullen, senior scientific officer in charge of potato trials and propagations; Dr. F. Earnshaw, economic botanist; and Messrs. P. J. Jones, A. F. Kelly, G. W. Mann, L. A. Willey, A. Main, G. G. Graham, J. D. Ivins and J. Munro, crop recorders at the trial centres.

EXPLORING MAGNETIC FIELDS

AN article by Lillian Shapiro (*Bell Lab. Rec.*, 23, No. 8; August 1945) describes means and methods devised for exploring the magnetic fields employed for guiding the electron stream in a cathode ray tube. Search coils are used in the method and a special winding machine and technique were developed to produce them.

Two coils with the axis of one at right angles to that of the other are wound on a common mandrel, and this assembly, with an outside diameter of about 0·2 in., is slipped into the end of a very thin-walled plastic search tube in such a way that one of the coils is concentric with the tube. As this search tube is moved along the axis of the tube, this latter coil will always be in a position to measure the component of the flux along the z-axis, while the other coil may be used to measure the components along the other two axes, turning the tube first so that the coil is perpendicular to the x-axis and then turning it 90° to bring it perpendicular to the y-axis.

Since such a search tube cannot actually be inserted in a cathode ray tube, exactly equivalent conditions are simulated by using a solid plastic cylinder with an outside diameter the same as the cylindrical section of the cathode ray tube. This plastic cylinder is accurately drilled longitudinally with twenty-one holes. It is then slipped inside the deflexion assembly of the cathode ray tube just as the tube itself would be. The magnetic fields set up in the plastic cylinder are thus exactly the same as those in a cathode ray tube when the same deflexion assembly is used.

The search tube carrying the exploring coils is inserted successively in the twenty-one holes of the cylinder, and a number of readings is taken in each so as to record the field at successive positions along the length of the tube. At each position, a reading on the coil that is concentric with the tube gives the z component of the field. Readings of the x- and y-components are made with the transverse coil, which may be rotated to any desired position merely by turning the tube. On the end of the tube remote from the exploring coils, there is a protractor from which the x- and y-axes may be determined.

One of the holes in the plastic block is exactly down the centre. The maximum field in this hole is usually rectilinear, with a component along one axis

only, and is generally opposite the centre of the windings inducing the field under measurement. The ordinary procedure is to take the first reading at this point. The direction of this field, which may be considered as along the x-axis, is determined by turning the transverse exploring coil until a null reading is obtained, and the angular position of this null reading is determined from the dial. This represents the y-axis, and 90° from this position is the x-axis. This determines the angular positions on the dial for the x- and y-axis, which will be used for all subsequent readings. The transverse exploring coil is then turned to be at right angles to the x-axis so as to obtain a reading of the maximum field. All other readings can then be given as a percentage of this maximum, which may ultimately be calibrated for actual field strength.

After the maximum field at the centre has been determined, the coil is moved along the z-axis in the same hole, and readings taken of all three components at short intervals. Where the field strength is changing rapidly, readings may be made at intervals as small as 0·05 in., distance being read on the graduated brass rod that carries the search tube. Farther out from the centre, where the field is weaker and is changing less rapidly, the distance between readings may be increased. Similar sets of readings can then be taken throughout the length of the remaining twenty holes.

NEPHRIDIA AND GENITAL DUCTS

THE last two issues of the *Quarterly Journal of Microscopical Science* (86, Pts. II, III and IV) contain one memoir, and they will be received with mixed feelings of gratitude and sadness by zoologists throughout the world. Gratitude because they contain such an admirable review of the subject of nephridia and genital ducts, and sadness because the second part contains a notice of the death of their distinguished author, Prof. E. S. Goodrich. The reviewer suggests that, if the type is still available, the publishers of the journal consider the possibility of adding some personal notes and issuing the two parts together as a memorial volume. The publication of the second number almost coincides with Prof. Goodrich's twenty-five years as editor of this famous journal; while his numerous publications in this field, in which he was an acknowledged master, extend over more than fifty years and, with one exception, have appeared in it—surely an exceptional record.

Accounts of the excretory organs and the genital ducts in a wide range of animals occurred frequently in previous literature, but they were difficult to correlate because of the lack of a generally accepted nomenclature, in part due to the fact that their true nature and origin were not properly understood. After original investigations of his own, Prof. Goodrich published in 1895 a memoir "On the Cœlom, Genital Ducts and Nephridia". In this for the first time the relationships of these structures were clarified, a much more satisfactory terminology was proposed and a series of important homologies pointed out. This work became a classic and formed a secure foundation for all future investigations on these topics.

In the fifty years that have passed since its appearance, a large volume of work along the same lines has been published, including noteworthy contributions by Prof. Goodrich himself and others directly inspired by him. Naturally much has been added to our knowledge and new types of these structures discovered, and these are all referred to in their appropriate places in the present memoir. In spite of the elaboration of certain details, almost no modification of the fundamental ideas originally put forward has been found necessary. The present memoir bears the title "The Study of Nephridia and Genital Ducts since 1895" and is self-explanatory. It covers the whole range of triploblastic animals from the Platyhelmia up to and including the Vertebrata. It is illustrated by 100 text-figures and is furnished with a full bibliography. There is no doubt that, like its predecessor, it will furnish the standard work of reference for many years to come.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, May 28

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 4.45 p.m.—Discussion on "Eugenically Desirable Types" (to be opened by Mr. Geoffrey Eley, followed by Mrs. C. Bosanquet and Dr. Maurice Newfield).*

LONDON ASSOCIATION OF UNIVERSITY WOMEN (at the Royal Institution, Albemarle Street, London, W.1), at 5.30 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "The History of the Royal Institution".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Dr. A. Porter: "The Design of Automatic and Manually Operated Control Systems".

Wednesday, May 29

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Major W. H. Cadman: "Colloidal Carbon".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. R. G. D. Allen: "Mutual Aid between the United States and the British Empire, 1941–45".

Thursday, May 30

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (at Houghton Street, Aldwych, London, W.C.2), at 4.45 p.m.—Prof. E. R. Hondelink: "The Organisation and Control of European Inland Transport".*

Friday, May 31

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "The Ionosphere" (to be opened by Sir Edward Appleton, G.B.E., F.R.S.).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MATHEMATICS—The Clerk to the Governors, Mid-Essex Technical College, Market Road, Chelmsford (June 1).

ENTOMOLOGIST for Colorado beetle, potato root eel-worm and general advisory work—The Secretary, States' Committee of Agriculture, 6 Bond Street, St. Helier, Jersey (June 1).

LECTURER IN CHEMISTRY up to B.Sc. standard—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 6).

LECTURER IN PHYSICS AND MATHEMATICS—The Registrar, Merchant Venturers' Technical College, Bristol 1 (June 6).

LECTURER (ungraded), an ASSISTANT LECTURER (ungraded), and DEMONSTRATORS (3), IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Liverpool (June 7).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (June 15).

TECHNICAL DEVELOPMENT SUPERVISOR for the organisation and supervision of a Technical Development Section—The Secretary, Turf Development Board, 21 Fitzwilliam Square, Dublin (June 15).

PROFESSOR AND HEAD OF THE DEPARTMENT OF ENGINEERING—The Secretary, The University, St. Andrews (June 29).

MYCOLOGIST at the Tea Research Institute of Ceylon, Talawakelle, Ceylon—The Secretary, Ceylon Association in London, King William Street House, Arthur Street, London, E.C.4 (June 30).

RESEARCH WORKERS to take part in an investigation of the distribution of drugs in cells using radioactive elements—Prof. Gaddum, Pharmacological Department, The University, Edinburgh (June 30).

LECTURER IN MATHEMATICS AND SCIENCE at the British Institute, Cairo—The Director of Education, British Council, 3 Hanover Street, London, W.1.

LECTURER IN MATHEMATICS, qualified to teach to the standard of the Special Degree of London University—The Registrar, Municipal College, Portsmouth.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Education. Higher Technological Education: Report of a Special Committee appointed in April 1944. Pp. 32. (London: H.M. Stationery Office, 1945.) 6*d*. net. [611

Royal College of Surgeons of England. Scientific Report for the Year 1944–1945. Pp. 24. (London: Royal College of Surgeons of England, 1945.) [611

The Internal Administration of an International Secretariat: Some Notes based on the Experience of the League of Nations. By Chester Purves. (Post-War Problems.) Pp. 78. (London and New York: Royal Institute of International Affairs, 1945.) 4*s*. 6*d*. net. [611

British Rubber Producers' Research Association. Publication 62: Two New Modifications of the Fourier Method of X-Ray Structure Analysis. By A. D. Booth. Pp. 6. (London: British Rubber Producers' Research Association, 1945.) [611

Permanent Committee on Geographical Names for British Official Use. A Gazetteer of Greece. Pp. xxiii+161. 7*s*. 6*d*. Glossaries 1: Modern Greek. Pp. xxxv+50. 2*s*. 6*d*. Glossaries 2: Russian. Pp. 56. 2*s*. 6*d*. Glossaries 3: Albanian. Pp. 38. 1*s*. 6*d*. Glossaries 4: Serbo-Croat and Slovene. Pp. 48. 2*s*. 6*d*. Glossaries 5: Romanian. Pp. 60. 1*s*. 6*d*. Glossaries 6: Thai (Siamese). Pp. xxv+74. 2*s*. 6*d*. Glossaries 7: Turkish. Pp. xx+84. 2*s*. 6*d*. (London: Royal Geographical Society, 1942–1945.) [611

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Thirty-eighth Annual Report, 1944–45. Pp. 34. (Cardiff: National Museum of Wales, 1945.) [2211

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 62, Part 2, No. 16: Studies in Practical Mathematics, 4. On Linear Approximation by Least Squares. By Dr. A. C. Aitken. Pp. 138–146. 1*s*. 6*d*. Vol. 62, Part 2, No. 17: The Regraduation of Clocks in Spherically Symmetric Space-times of General Relativity. By Dr. G. C. McVittie. Pp. 147–155. 1*s*. 6*d*. Vol. 62, Part 2, No. 18: The Riemann Tensor in a Completely Harmonic V_4. By H. S. Ruse. Pp. 156–163. 1*s*. 3*d*. (Edinburgh and London: Oliver and Boyd, 1945.) [2211

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